

***AN EMPIRICAL ANALYSIS OF THE ROLE OF  
AGRICULTURE IN ACCELERATED DEVELOPMENT IN  
TWO DISTRICTS OF BOPHUTHATSWANA, 1978-1991***

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***DEDICATED TO***

my father

**KASANDA MUSAKAYI JOSEPH**

my mother

**BANSENGA TSHIMUNGU JOHANNE**

with love and care

and my wife

**BIUMA KABAMBA KONGOLO**

for support

**ABSTRACT****AN EMPIRICAL ANALYSIS OF THE ROLE OF AGRICULTURE IN  
ACCELERATED DEVELOPMENT IN TWO DISTRICTS OF  
BOPHUTHATSWANA, 1978-1991**

by

MUKOLE KONGOLO

The planning of agricultural development and the implementation of its policy requires knowledge of the impacts and necessary adjustments that would take place as a result of the introduction of a new approach to agricultural practices. In essence, the effects of an improved approach to agricultural development could be characterised by impacts on the cost structures or the product mix of individual firms; with shifts in individual demand curves for production factors; shifts in product supply curves; impacts on growth and development as well as impacts on the distribution of the total and *per capita* income. The analysis and understanding of these effects provide useful information to the decision-making process in setting up guidelines for research, policy issues and the planning of research activities for agricultural development.

The main purpose of this study has been to increase knowledge on the role of agriculture for accelerated development in the area of study, and to contribute information on how it can affect the economic growth and development of the region.

Specifically, the objectives of this research were:

- i. to examine and analyse the role of agriculture for accelerated development in Bophuthatswana during the period of independence up to 1991;
- ii. to examine the implementation of an agricultural development policy with the political commitment to reduce poverty;
- iii. to investigate the obstacles and opportunities of the agricultural development process and its redirection for economic development;
- iv. to compare the appropriateness of the agricultural development process with the present theory of agricultural production;
- v. to analyse certain popular opinions about the importance of the agricultural development process in the area of study, and

- vi. to develop an econometric model for analysis of some specific objectives of this research.

The focus of this study was on the development of an analytical framework which could be used to analyse the potential role of agriculture for accelerated development in Bophuthatswana up to 1991.

The instrument of analysis has been a regional macro-economic Cobb-Douglas model of farmer's decision-making with respect to resource allocation and production. The main purpose of the model was to determine the capacity of crop production and other farm resources on the basis of their opportunity costs within alternative usage.

The results of the study indicated that in response to agricultural policy changes, both small and large farmers could change to a certain extent with change in land utilisation, crop production, input demand and income patterns over time. These elements were explained by the magnitude of the coefficients of elasticities calculated for both crops analysed in this study.

The introduction of new farming methods would lead to significant increases in the areas under maize and wheat production. The nett returns to resources in farming could also be increased significantly with improvements in crop yields and productivity. Because of different types of technology used by both small and large farmers, income of the large farmers showed a significant growth rate in comparison to small farmers.

The role of agriculture for economic growth and development has been described in this study as one of the most important factors contributing to the GDP of a country. A good agricultural sector has been the "cultural back bone" of many a nation in providing cheap basic food, raw materials and also contribution to foreign exchange earnings. The agricultural sector also has a key role to perform in the industrialisation process of the national economy.

This research suggests that to promote agricultural growth and development in the study areas, policy instruments should be directed and based on a well defined set of objectives on the one hand and on the other hand it should also take into consideration the interrelationships among farm size groups, the existing state-of the agricultural sector and the conditions prevailing in the rural areas.

## **TABLE OF CONTENTS**

	<i>PAGE</i>
<b>ACKNOWLEDGEMENTS</b> .....	<i>i</i>
<b>ABSTRACT</b> .....	<i>iii</i>
<b>LIST OF FIGURES</b> .....	<i>xiv</i>
<b>LIST OF TABLES</b> .....	<i>xv</i>
<b>LIST OF APPENDICES</b> .....	<i>xvi</i>
<b>CHAPTER ONE</b> .....	<b>1</b>
<b>1. INTRODUCTION</b> .....	<b>1</b>
1.1 OBJECTIVES OF THE STUDY .....	1
1.1.1 Main objectives.....	1
1.1.2 Specific objectives .....	2
<b>1.2 HYPOTHESIS</b> .....	<b>2</b>
<b>1.3 THE NEED FOR THE STUDY</b> .....	<b>2</b>
1.3.1 Agricultural development history .....	3
1.3.2 Agricultural practices .....	3
1.3.3 Land tenure systems .....	4
1.3.4 Modernisation of agriculture .....	4
1.3.5 Agricultural productivity .....	5
1.3.6 Crop production .....	6
<b>1.4 SOME REQUIREMENTS FOR AGRICULTURAL DEVELOPMENT</b> .....	<b>7</b>
1.4.1 Strategy for agricultural development.....	7
1.4.2 Agricultural infrastructure .....	8
1.4.3 Nutritional standards.....	8
1.4.4 Farm labour productivity.....	8
1.4.5 Planning and agricultural research.....	9

1.4.6	Educational standards.....	9
<b>1.5</b>	<b>SCOPE OF THE STUDY .....</b>	<b>9</b>
<b>1.6</b>	<b>METHODOLOGY .....</b>	<b>10</b>
<b>1.7</b>	<b>STUDY OUTLINE.....</b>	<b>11</b>
<b>CHAPTER TWO .....</b>	<b>12</b>	
<b>IDENTIFICATION OF VARIABLES FOR ECONOMIC GROWTH.....</b>	<b>12</b>	
<b>2.1</b>	<b>INTRODUCTION .....</b>	<b>12</b>
<b>2.2</b>	<b>IDENTIFICATION OF MAIN VARIABLES TO DETERMINE ECONOMIC GROWTH THROUGH THE AGRICULTURAL SECTOR.....</b>	<b>12</b>
2.2.1	Variables from growth models .....	12
2.2.1.1	Swarn and Rawat growth model .....	12
2.2.1.2	Teotônio growth model.....	13
2.2.1.3	Arnold and Benneth growth model .....	13
2.2.1.4	Various inputs .....	13
2.2.1.5	Financial facilities.....	14
2.2.1.6	Change in attitudes.....	14
2.2.1.7	Incentives.....	14
2.2.2	Variables from theories of economic development through the agricultural sector.....	15
2.2.2.1	Neo-classical theory of development .....	15
2.2.2.2	Modern theory of development .....	15
2.2.2.3	Agricultural growth-oriented theory of development .....	15
2.2.2.4	Development theory through investment.....	16
2.2.2.5	Development theory in the Southern African context.....	16
2.2.2.6	Theory of household economics .....	17
2.2.2.7	A model of the traditional farm-household in Southern Africa.....	18
2.2.3	Other variables to consider in agricultural growth .....	18
2.2.3.1	Quality of land.....	19

2.2.3.2	Institutional change .....	19
2.2.3.3	Rural infrastructure .....	20
2.2.3.4	Land tenure systems .....	21
<b>2.3</b>	<b><i>THE ECONOMIC MODEL</i></b> .....	<b>21</b>
2.3.1	General considerations.....	21
2.3.2	Description of the production function.....	22
2.3.3	Specification of the production function .....	23
2.3.4	Formalisation of an economic model for agricultural change.....	25
<b>2.4</b>	<b><i>A MODEL FOR LIVESTOCK DEVELOPMENT IN THE AREA OF STUDY</i></b> .....	<b>28</b>
2.4.1	Carrying capacity .....	28
2.4.2	Stocking rates.....	29
2.4.3	Overgrazing and overstocking.....	30
<b>2.5</b>	<b><i>THE ROLE OF RESEARCH FOR AGRICULTURAL DEVELOPMENT</i></b> ...	<b>30</b>
<b>2.6</b>	<b><i>APPROACHES TO EMPIRICAL MEASUREMENTS IN AGRICULTURE</i></b> .....	<b>32</b>
2.6.1	Harberger's approach.....	32
2.6.2	Haggblade et al. approach .....	32
2.6.3	Cost-benefit approach .....	32
2.6.4	Houba and Kremers' approach .....	33
2.6.5	Impact analysis approach.....	33
2.6.6	Aggregate production functions and regression analysis approach.....	33
2.6.7	Furtado's approach.....	34
2.6.8	Stochastic dominance approach .....	34
2.6.9	General growth approach .....	35
<b>2.7</b>	<b><i>DIFFERENT APPROACHES TO THE ANALYSIS OF AGRICULTURAL DEVELOPMENT</i></b> .....	<b>35</b>
2.7.1	Production function analysis.....	35
2.7.2	Programming models .....	36

2.7.3	Econometric models .....	36
2.8	<b>CONCEPTUALISATION OF TECHNOLOGY OF PRODUCTION .....</b>	<b>36</b>
2.8.1	Distributional effects of technology .....	37
2.8.2	Integrated concept.....	37
2.8.3	Technological adaption .....	37
2.8.4	Unconventional variables .....	38
2.8.5	Mechanical technology and management .....	38
2.8.6	Appropriate technology .....	38
2.8.7	Relationship between technology and agricultural growth .....	39
2.8.8	Application of technology.....	39
2.8.9	Interrelationships with other factors .....	40
2.9	<b>CONCLUSION.....</b>	<b>40</b>
	<b>CHAPTER THREE.....</b>	<b>42</b>
	<b>REVIEW OF AGRICULTURAL GROWTH IN BOPHUTHATSWANA UP TO 1991.....</b>	<b>42</b>
3.1	<b>INTRODUCTION .....</b>	<b>42</b>
3.2	<b>THE GEOGRAPHICAL SETTING.....</b>	<b>42</b>
3.3	<b>SECTORAL CONTRIBUTION OF THE AGRICULTURAL SECTOR TO GDP.....</b>	<b>43</b>
3.4	<b>AGRICULTURAL SECTOR OF BOPHUTHATSWANA UP TO 1991 .....</b>	<b>45</b>
3.4.1	Traditional agricultural farming .....	45
3.4.2	Modern agricultural farming .....	45
3.4.3	General conditions .....	46
3.5	<b>CHARACTERISTICS OF AGRICULTURE IN THE AREA OF STUDY....</b>	<b>48</b>
3.5.1	Main objectives.....	49
3.5.2	Climate .....	49
3.5.3	Supply by the agricultural sector.....	49
3.5.4	The demand side .....	50
3.5.5	Maize production in the study area, 1978-91 .....	50

3.5.6	Wheat production in the study area, 1978-91 .....	53
3.5.7	Sorghum production in the area of study, 1978-91 .....	55
3.5.8	Growth of farm output .....	57
3.6	<b>CONCLUSION</b> .....	57
 <b>CHAPTER FOUR</b> .....		<b>59</b>
<b>AGRICULTURAL DEVELOPMENT POLICY IN BOPHUTHATSWANA UP TO 1991</b> .....		<b>59</b>
4.1	<b>INTRODUCTION</b> .....	<b>59</b>
4.2	<b>HISTORICAL BACKGROUND</b> .....	<b>59</b>
4.3	<b>THE NEED FOR AN AGRICULTURAL DEVELOPMENT POLICY FRAMEWORK</b> .....	<b>60</b>
4.4	<b>AGRICULTURAL DEVELOPMENT POLICY IN THE AREA OF STUDY</b> .....	<b>62</b>
4.5	<b>CROP PRODUCTION POLICY</b> .....	<b>63</b>
4.5.1	Objectives .....	63
4.5.2	Different crop production policy principles .....	63
4.5.3	Services rendered as part of agricultural policy.....	64
4.6	<b>AGRICULTURAL PRICE POLICY</b> .....	<b>65</b>
4.6.1	Objectives .....	65
4.6.2	Reformed agricultural price policy .....	65
4.7	<b>VOCATIONAL TRAINING</b> .....	<b>67</b>
4.7.1	Objective .....	67
4.7.2	Management of training.....	67
4.7.3	Literacy programme .....	68
4.8	<b>LAND TENURE POLICY</b> .....	<b>69</b>
4.9	<b>POLICY IMPLICATIONS</b> .....	<b>70</b>
4.9.1	Main arguments .....	70
4.9.2	Agricultural development strategy .....	71

<b>4.10</b>	<b>CONCLUSION.....</b>	<b>72</b>
<b>CHAPTER FIVE.....</b>		<b>75</b>
<b>METHODOLOGY OF DOMESTIC RESOURCE COST BENEFIT CALCULATION ....</b>		<b>75</b>
<b>5.1</b>	<b>INTRODUCTION .....</b>	<b>75</b>
<b>5.2</b>	<b>SOCIAL BENEFIT COST ANALYSIS.....</b>	<b>75</b>
<b>5.2.1</b>	The use of social benefit cost analysis .....	75
<b>5.2.2</b>	Criteria for social profitability .....	76
<b>5.2.3</b>	Net social profitability (NSP) .....	77
<b>5.2.4</b>	Social marginal productivity (SMP).....	78
<b>5.2.5</b>	Domestic resource cost (DRC).....	79
<b>5.3</b>	<b>POPULATION PRESSURE ON AGRICULTURE.....</b>	<b>81</b>
<b>5.4</b>	<b>THE CULTURAL APPROACH.....</b>	<b>82</b>
<b>5.5</b>	<b>CONCLUSION.....</b>	<b>85</b>
<b>CHAPTER SIX.....</b>		<b>86</b>
<b>DATA COLLECTION PROCEDURE.....</b>		<b>86</b>
<b>6.1</b>	<b>INTRODUCTION .....</b>	<b>86</b>
<b>6.2</b>	<b>PLANNING OF THE SURVEY.....</b>	<b>86</b>
<b>6.3</b>	<b>THE QUESTIONNAIRE.....</b>	<b>88</b>
<b>6.3.1</b>	Observations from the questionnaire .....	88
<b>6.4</b>	<b>SAMPLE FRAMEWORK .....</b>	<b>89</b>
<b>6.5</b>	<b>THE SAMPLE SIZE.....</b>	<b>90</b>
<b>6.6</b>	<b>SAMPLE UNIT .....</b>	<b>93</b>
<b>6.7</b>	<b>DIFFERENTIATION IN SAMPLE .....</b>	<b>93</b>
<b>6.8</b>	<b>REASONS FOR BIAS AND SAMPLING ERRORS.....</b>	<b>94</b>
<b>6.9</b>	<b>VARIATIONS IN DATA .....</b>	<b>95</b>
<b>6.10</b>	<b>CONCLUSION.....</b>	<b>95</b>

<b>CHAPTER SEVEN</b> .....	<b>96</b>
<b>MATHEMATICAL FORMULATION OF THE MODEL</b> .....	<b>96</b>
<b>7.1 INTRODUCTION</b> .....	<b>96</b>
<b>7.2 MEASURING ECONOMIC PROGRESS</b> .....	<b>96</b>
7.2.1 Mathematical programming models .....	97
7.2.2 Econometric models .....	97
<b>7.3 COMPONENTS OF A MODEL</b> .....	<b>98</b>
7.3.1 Dependent variable of the model.....	98
7.3.2 Independent variables of the model.....	98
7.3.3 Income component .....	99
7.3.4 The yield component .....	99
<b>7.4 THE DATA REQUIREMENTS FOR THE MODEL</b> .....	<b>100</b>
7.4.1 Initial conditions.....	100
7.4.2 Constant parameters .....	100
7.4.3 Time-varying parameters or exogenous variables .....	101
<b>7.5 ELASTICITY ESTIMATES FOR CROPS</b> .....	<b>101</b>
<b>7.6 STRUCTURING FOR MARKETING OF MAIZE, WHEAT AND SORGHUM</b> .....	<b>102</b>
<b>7.7 AGRICULTURAL PRICE INTERVENTIONS</b> .....	<b>102</b>
<b>7.8 CROP SUPPLY RESPONSE FUNCTION</b> .....	<b>104</b>
<b>7.9 CONSIDERATIONS ON THE MODEL</b> .....	<b>105</b>
7.9.1 The conceptual model .....	106
7.9.2 Linear model.....	106
7.9.3 Cobb-Douglas model .....	107
7.9.3.1 Model specification .....	107
7.9.3.2 Characteristics of the Cobb-Douglas model .....	107
7.9.3.3 Limitations and assumptions of the Cobb-Douglas model.....	108
7.9.3.4 Estimates of the production function .....	109
<b>7.10 CONCLUSION</b> .....	<b>109</b>

<b>CHAPTER EIGHT</b> .....	<b>111</b>
<b>EMPIRICAL RESULTS AND DISCUSSIONS</b> .....	<b>111</b>
8.1 <b>INTRODUCTION</b> .....	<b>111</b>
8.2 <b>SELECTION OF THE SUPPLY FUNCTION</b> .....	<b>111</b>
8.3 <b>INDIVIDUAL COMMODITY ANALYSIS</b> .....	<b>112</b>
8.3.1    Aggregate production function .....	113
8.3.2    Maize supply estimates: large and small farmers.....	114
8.3.3    Review .....	117
8.4 <b>WHEAT PRODUCTION: LARGE AND SMALL FARMERS</b> .....	<b>117</b>
8.4.1    Statistical results.....	117
8.4.2    Review .....	120
8.5 <b>SORGHUM PRODUCTION: LARGE FARMERS</b> .....	<b>121</b>
8.5.1    Statistical results.....	121
8.5.2    Sorghum and maize output supply conflict analysis.....	123
8.5.3    Review .....	126
8.6 <b>CONCLUSION</b> .....	<b>127</b>
<b>CHAPTER NINE</b> .....	<b>129</b>
<b>SUMMARY AND RECOMMENDATIONS</b> .....	<b>129</b>
9.1 <b>INTRODUCTION</b> .....	<b>129</b>
9.1.1    The study problem .....	129
9.1.2    Objective of the study .....	129
9.1.3    Methodology .....	130
9.1.4    Review of the results of the research.....	131
9.1.5    Review of the results of the model .....	133
9.2 <b>IMPLICATIONS FOR AGRICULTURAL DEVELOPMENT AND POLICY</b> .....	<b>135</b>
9.2.1    Implications for agricultural development .....	135
9.2.2    Implications for agricultural policy .....	136

<b>9.3</b>	<b><i>LIMITATIONS OF THE STUDY</i></b> .....	<b>137</b>
<b>9.4</b>	<b><i>SUGGESTIONS</i></b> .....	<b>138</b>
<b>9.5</b>	<b><i>RECOMMENDATIONS FOR FUTURE RESEARCH</i></b> .....	<b>139</b>
9.5.1	Resource allocation between farm size groups.....	139
9.5.2	Improvements in the model.....	139
9.5.3	Income distribution .....	139
9.5.4	Relationship of the model to other sector models .....	140
9.5.5	Improvements of data base.....	140
	<b><i>BIBLIOGRAPHY</i></b> .....	<b>141</b>

***LIST OF FIGURES***

FIGURE 1: The stages of agricultural change. ....	26
FIGURE 2: An economic model of agricultural change.....	27
FIGURE 3: The former Republic of Bophuthatswana. ....	44
FIGURE 4: The former Republic of Bophuthatswana and the population distribution in 1985. ....	87

***LIST OF TABLES***

TABLE 1: Crop production in the area of study during 1977/78 - 1990/91 (in metric tons). .....	6
TABLE 2: Summary of findings on livestock census in the area of study, 1991.....	29
TABLE 3: Contribution of agricultural sector to GDP, Bophuthatswana up to 1991 (R'000).....	43
TABLE 4: Estimated domestic income of the main sources of activities at the market prices, Bophuthatswana, 1985-1987, (R'000). .....	47
TABLE 5: Bophuthatswana drought relief initiated by the government, 1988. ....	48
TABLE 6: R.S.A. government contributions towards the maize industry, 1978/79 - 1985/86. ....	51
TABLE 7: Maize: Area and production of commercial agriculture by province, 1980/81 - 1991/92. ....	52
TABLE 8: World production and stock position for coarse grain and wheat for the 1976/77 to 1985/86 marketing seasons.....	55
TABLE 9: Estimated grain sorghum production in the area of study, 1985/86. ....	56
TABLE 10: Some of the training courses offered by Agricor Training Department: February-November 1991.....	68
TABLE 11: Some policy settings, policy measures and strategies in agriculture. ....	74
TABLE 12: Sample framework and size of farming operations in Madikwe and Taung districts, 1991. ....	91
TABLE 13: Regression results for maize production in the area of study, 1978-91. ....	115
TABLE 14: Regression results for wheat production in the area of study, 1978-91. ....	118
TABLE 15: Regression results for sorghum supply in the area of study, 1978-91. ....	122
TABLE 16: Regression results for sorghum cross-elasticity with respect to maize producer price in the area of study, 1978-91.....	125

*LIST OF APPENDICES*

Appendix A <sub>1</sub> :	Simple cultural model calculation.....	160
Appendix A <sub>2</sub> :	The questionnaire.....	163
Appendix A <sub>3</sub> :	Results of the surveys.....	176
Appendix A <sub>4</sub> :	The probability sampling procedures.....	183
Appendix A <sub>5</sub> :	Treatment of statistical problems.....	186
Appendix B <sub>1</sub> :	Maize producer prices, 1990-91 .....	192
	Sorghum floor prices, 1990-91 .....	193
Appendix B <sub>2</sub> :	Wheat producer prices, 1990-91 .....	196
Appendix B <sub>3</sub> :	Hypothesis testing .....	199
Appendix C <sub>1</sub> :	Squared partial correlation .....	202
Appendix C <sub>2</sub> :	Squared partial correlation .....	204

## **CHAPTER ONE**

### **1. INTRODUCTION**

#### **1.1 OBJECTIVES OF THE STUDY**

##### **1.1.1 Main objectives**

The need and urgency to improve the quality of life in the area of study's underdeveloped rural areas was a matter of national importance. The emphasis was placed on development strategies to promote economic growth and to meet the basic needs of the poorest communities. On the other hand, there appeared to be a lack of appropriate organisational structures to adequately address the role of agriculture for accelerated development in the study area.

The context in which this research is carried out is related to the role of agriculture for accelerated development in Bophuthatswana up to 1991. It is concerned with the analysis of the macro-economic variables that could promote and upgrade the agricultural development process in the study area. Development is the conscientisation process by which people are awakened to opportunities within their reach. It starts with and progresses through the people. Development then takes place when, where and how the people concerned want it (Gwanya, 1989:1-2).

The objectives of development are to bring about a sustainable improvement in the well-being of the individuals and to bestow benefits to all. But if undue privileges, extremes of wealth and social injustices persist, development fails in its essential purpose (Pradip, 1984:vi). Hence, the role of the human factor in the development equation should be emphasised for both quality and quantity, thereby involving people's beliefs and traditional cultures.

The main purpose of this study is to increase knowledge on the role of agriculture for accelerated development in Bophuthatswana up to 1991 and how it can contribute to economic development and growth of the area of study. The research combines the results of different surveys conducted in the area of study to investigate this role of agriculture for accelerated development in Bophuthatswana up to 1991. This would determine how the aspirations of the people could be

channelled towards a better quality of life and be integrated into meaningful socio-economic changes.

### **1.1.2 Specific objectives**

Specifically, the objectives of the research are:

1. Analysis of certain popular opinions about the importance of the agricultural development process.
2. Examination of the implementation of an agricultural development policy with the political commitment to reduce poverty.
3. Examination and analysis of the role of agriculture in Bophuthatswana during the period following independence, up to 1991.
4. Investigation into the obstacles and opportunities of the agricultural development process, and its redirection for the acceleration of development in the area of study. This would facilitate the timing schedule attached to the national development of agriculture and the analysis of the allocation of resources for increased agricultural production.
5. Focus on the comparison of the appropriateness of the agricultural development process in Bophuthatswana up to 1991 with the present theory of development.
6. Development of an econometric model for analysis of some specific objectives of this research, e.g. the model developed in section 2.4.

## **1.2 HYPOTHESIS**

The hypothesis for this study is that the role of agriculture for accelerated development is significant for economic growth and development.

## **1.3 THE NEED FOR THE STUDY**

Basically the study is concerned with the analysis of agricultural growth for economic development to create changes in the living conditions of the people in the area of study. Theoretical analysis of agricultural growth in developing countries,

including agricultural practices in the study area, are discussed to explain the need for this research.

### ***1.3.1 Agricultural development history***

The most commonly used measure of the size and behaviour of a country's economic development is the Gross Domestic Product (GDP), which is the total value of goods and services. The nature of past structural changes in the South African economic development (Bophuthatswana included) may be illustrated through comparison of the contribution of agriculture to GDP during 1911 and 1988; which was 21 percent and 6 percent respectively (Truu, 1989:26).

Agriculture, as a business, has many different cycles which can be explained in terms of real factors, focus on real events and practices as well as its changes. Historically, agricultural supply only adjusts slowly to changes in demand, because it takes time for the production process to adjust to changes in demand (Levin, 1990:85).

Experience has shown that despite the high rates of economic growth during the 1960's, large numbers of people in developing countries have remained poor and their absolute and relative economic positions have even deteriorated (Keeton, 1984:277).

Although there had been some growth in the agricultural production during the 1970's, most of this was in the form of subsistence production, which had not kept pace with the population growth (Bembridge, 1986:22). However, it was found (e.g. in Taiwan) that a prosperous small-scale agricultural sector contributed to economic development in the rural areas. Which means that a sustainable small-scale agricultural base could be established and maintained by supporting especially the development of rural industries (Erskine, 1992(b):23-24).

### ***1.3.2 Agricultural practices***

The agricultural practices in the study area tend to lean towards subsistence agricultural systems commonly found in many parts of underdeveloped rural areas in LDC's. The three main agricultural activities in the area of study are gardening, swamp farming and dryland cropping with relatively low productivity (Taylor, 1988:465).

Agriculture has remained relatively free of modernisation in the area of study, and it is of special interest to farmers to use more appropriate technologies in farming. The acceptance of modern farming processes is still a problem. This process is slow because of the traditional subsistence economy in most rural areas. Therefore, fundamental acculturation and change of attitudes by the people is needed before the traditional approach could be replaced with a modern agricultural production process (Taylor, 1988:465).

Subsistence agriculture traps small farmers into a pattern of farming in which they practice methods requiring the least investment and giving them the least return. Poor farming practices have resulted in the deterioration of resources (Bembridge, 1986:28-30).

### **1.3.3 *Land tenure systems***

The traditional system of land ownership and land use has led to fragmentation of the resources, which means that a specific strategy of development is necessary for the development of the agricultural sector as a whole (Department of Development Aid, 1989:5). This explanation is based on agricultural development of the traditional farm household in the study area, who operates within the tribal and state tenure systems and cultivates most of the land under food crops.

According to Low (1984:294) it is largely in the subsistence farming sector where the greatest potential for agricultural growth exists, but at the same time socio-economic factors place severe constraints on the realisation of its economic potential.

### **1.3.4 *Modernisation of agriculture***

An understanding of the economic nature of the traditional agricultural sector is an advantage for the modernisation of the agricultural sector as a process to economic development.

Today there is widespread recognition that the challenge faced by those involved in agricultural modernisation in Africa is organisational and behavioural rather than a lack of resources (Simpson and Evangelou, 1984:13; Bennet, 1984:53; Dyson-Hudson, 1985:161). However, Wharton (1979:101) concludes that transformation depends on the decision to invest in agriculture to make modern high-pay-off inputs

available to all farmers. Productivity could be significantly increased if they can adopt the practices of modern farming systems.

### *1.3.5 Agricultural productivity*

The agricultural productivity in most of the area of study has not generally been able to be a source of increased income for the rural households (Humphreys, 1989:6). This is a general phenomenon from the viewpoint of agricultural development process in most underdeveloped rural areas. The area of study and the agricultural sector have not succeeded in meeting the increased demand for food by those who have migrated to the urban areas and benefited from increased incomes (Mekgwe, 1987:91).

The effort to raise the agricultural productivity to the full socio-economic potential is the perfect "linkpin" of the development process. If this process does not provide incentives to the communities, the whole process will remain fruitless and will delay progress for socio-economic development (Schweiger, 1990:20).

In the typically agrarian economies of most developing rural areas, agricultural productivity should make a substantial contribution to the national economic growth over a wide front in the following ways (Arnon, 1987:5):

1. increases in food production by improving nutritional levels in quantity and quality;
2. provision of productive work for the increasing rural population;
3. production of export crops as a source of foreign exchange earnings, and
4. support of industrial development.

The agricultural productivity process has not been followed by all the countries in the same manner. There are countries which have started devoting resources to promote their agricultural productivity long before others. Some have adopted productivity of agriculture through development programmes and have done little to implement them. Others have promoted both the agricultural productivity and industry and have generally been successful (Arnon, 1987:5).

**TABLE 1: Crop production in the area of study during 1977/78 - 1990/91 (in metric tons).**

Years	Maize	Sorghum	Sun-flower	Ground-nuts	Wheat	Cotton	Dry Beans	Dry Peas
77/78	6573	1326	-	-	2865	-	-	-
78/79	24102	3360	283	660	3327	-	-	-
79/80	47351	576	420	1495	4395	-	-	-
80/81	87327	517	1892	1067	4766	-	-	-
81/82	38612	463	1571	1204	6483	1724	-	-
82/83	22510	458	762	1147	7080	1926	5	322
83/84	2079	406	559	571	4666	1476	20	208
84/85	47049	412	1775	990	5870	3213	8	640
85/86	23156	957	411	195	6535	2700	299	1956
86/87	91281	5418	8151	1563	8000	1000	15	2500
87/88	74841	7247	4049	907	7600	1713	330	2098
88/89	85853	2891	3351	2728	13587	997	-	-
89/90	119369	35724	3862	2324	14292	1060	-	-
90/91	73866	27189	1983	2520	5840	701	-	-

Sources: Richard (1987:56)  
Agricor, *Annual Reports*, 1987-89  
Bophuthatswana Marketing Board, *Annual Reports*, 1989-91

Looking at the trend of maize, wheat and sorghum production in the area of study (Table 1), the following comments can be made. Maize production has been satisfactory during 1979-1983 period, but had a drastic decline in 1984. This situation became normal during the period 1985-1991. The data for 1989-1990 seems to be misleading and inaccurate in comparison to the other years. Wheat production has been more satisfactory for all the agricultural seasons, with a small drop in the quantity produced during 1991. However, sorghum production in the area of study has not been satisfactory because it has been characterised by wide fluctuations in the quantities supplied, except for 1989-1991.

### 1.3.6 Crop production

Despite the improved crop yields, the financial situation of many farmers producing maize and other grains is still far from satisfactory in comparison to their

counterparts in the summer grain areas of the RSA. The situation was complicated by the recent drought conditions (Table 1).

The increased interest in the economics of crop production changes in most parts of the world after the early 1960's, is due to the recognition of the crucial role played by agricultural crop production in economic growth and development (Griliches, 1963:335-340).<sup>1</sup> This growing interest is the result of the impact of many studies on the role of agriculture in the economy. On one of these, Van Heerden stated that improvement in services to agricultural production is much needed to substantiate economic growth (Groenewald and Koch, 1989:372).

## **1.4 SOME REQUIREMENTS FOR AGRICULTURAL DEVELOPMENT**

### **1.4.1 Strategy for agricultural development**

Any strategy to modernise agriculture is often seen as the basic means of strengthening the role of the agricultural sector in the general process of economic growth and development. Therefore, an effective strategy for economic growth and development depends on the country's capacity to generate resources which can contribute to growth in the agricultural productivity. In other words, the concept of resource allocation in agriculture has become a focal theme in understanding agricultural development.<sup>2</sup>

The regional government, through the Agricultural Development Corporation, took essential steps in defining the role of agriculture for accelerated development. It indicated that a high priority should be given to the optimal utilisation of available resources (Agricor, 1989:8). This strengthens the argument by Erskine (1992(a):22) who argues that growth in agricultural productivity is essential for both economic development and transformation of the society, because economic development encompasses the satisfaction of basic human needs.

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1 For contributions which emphasise the role of agricultural changes in economic growth, see e.g. Johnston and Southworth, 1979:5; Mellor, 1979:23; Van Zyl and Van Rooyen, 1990:273; Van Rooyen and Machethe, 1991:175-176.

2 See for example Hahn and Matthews, 1964:779-902; Tweeten and Hine, 1965:40-45; Solow, 1956:65-94 and Bembridge, 1986:28.

#### 1.4.2 *Agricultural infrastructure*

Many authors like Raisuddin and Mahabub (1991:24) believe that infrastructure affects agricultural productivity through prices, diffusion of technology, efficient use of resources and an efficient combination of inputs for better outputs. Meanwhile, Buijs (1982:8-9) agrees in principle that to produce and to improve the quality of life, people need resources which influence the rates of productivity in agriculture.

On the other hand, people also need knowledge of how to acquire these resources, which at the last stage of development will become a resource by itself. Buijs (1982:9) concludes that the possibility of people to dispose of resources depends on their ability to manipulate them, since they are the "access routes" to economic development.

Besides the increase in inputs, Shenggen (1991:266) points out that an accounting approach should be used to institutionalise reforms because this refers, *inter alia*, to the household production system which could contribute to growth in production. Therefore, continued institutional reform should always accompany the corresponding technological changes (F.A.O., 1981:1).

#### 1.4.3 *Nutritional standards*

Productivity is greatly affected by nutritional standards. Hence, the national objectives and strategies on agricultural productivity should focus on economic growth through nutritional improvements (F.A.O., 1981:1). An effective use of resources through adequate incentives for agricultural productivity and deregulation of prices of food could be in favour of sharing resources and the benefits of economic progress (Dolny, 1991:216).

#### 1.4.4 *Farm labour productivity*

Haggblade *et al.* (1991:36) believe that raising farm labour productivity is important. Not only because it permits the release of labour from agriculture to nonagricultural pursuits, but also because it boosts *per capita* income to levels that enable consumer diversification from food into nonfood items. However, this requires efforts to remove the bias against agriculture, often embedded in macro-economic policies, and to raise agricultural output and productivity by encouraging the adoption of new farming systems. Otherwise the country is faced by the vicious circle of low productivity of the subsistence agricultural sector (Arnon, 1987:4).

#### **1.4.5 *Planning and agricultural research***

In the process of agricultural development, the development planners should show the way out on how to promote economic growth. There is a need to liberate, reinforce and support economic development planning which emphasises agricultural productivity growth (Erskine, 1992(a):24). According to Fenyes (1982:1) all planning for agricultural development must be formulated at both national and regional levels. To be consistent, planning must be in harmony with the aspirations of the communities concerned.

An organised agricultural development research policy is an important part of the agricultural modernisation process. Significant growth cannot always be brought about by the re-allocation of resources in the traditional agriculture (Schultz, 1985:25). Adaptive agricultural development research is vital for the development of agriculture. A research network is an essential element to help address the needs of the farmers (Erskine, 1992:24).

#### **1.4.6 *Educational standards***

Erskine (1990:16) believes that educational standards play a key role in the process of agricultural growth. Farmers need to improve their self-managing skills as individuals in order to understand the concept of resource allocation and combination for the development of the agricultural sector in general and the traditional agricultural sector in particular.

### **1.5 *SCOPE OF THE STUDY***

The economic impact of agricultural development changes may be seen in a sequence of steps following the incorporation of agricultural production, distribution and utilisation of the major components of the agricultural system (Cox, 1985:18). A thorough understanding of the components of the agricultural sector is important to set up a realistic goal, to formulate an acceptable strategy and to develop and implement sound planning.

Geographically this study is limited to the area known up to 1994 as Bophuthatswana. Bophuthatswana was composed of seven geographical units (Masibi and Coetzee, 1989:6).<sup>3</sup>

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3 See section 3.2; Figure 1.

This research investigates the role of agriculture for accelerated development in Bophuthatswana up to 1991 by the use of economic development principles. A range of techniques and approaches to agricultural development as it has been practically used in South African agriculture is to be explored to study the present state of agriculture in Bophuthatswana. Focus on quantitative methods is emphasised as it is explained in the section on methodology.

This study is focussed on the above aspects of agricultural development by following an *ex-ante* approach (Bembridge, 1988(b):124). Consideration is given to the analysis of various situational, personal, sociological, socio-economic, socio-psychological and other variables which could influence agricultural productivity for the development of a country. One should, for example concentrate on a few cases to capture insights which large sample surveys can completely ignore (Thormeyer, 1988:125). This requires that the quality of life should be investigated by analysis of personal history, taking into consideration the collaboration of various disciplines because no single discipline possesses the tools and insights to totally understand all farmers' strategies. The adaptive interaction of these farmers with their environment and the most effective ways of assisting them to improve their agricultural production and ultimately their standards of living, should be investigated.

## 1.6 METHODOLOGY

The instruments of the analysis used in this study include both a review of the relevant literature, mostly from different journals as well as some relevant books and also from the existing studies in the field of research. Empirical data collection and personal interviews form the other part of the methodology. For any economic investigation, statistics are essential for data collection, analysis and interpretation of the results (Linch, 1990:10).

An econometric/mathematical model of the rural households in the area of study to stimulate agricultural development in the region was developed. The model aggregates enterprise levels of activities predicted for the rural households. Several economic scenarios are attempted with the model so as to predict the reaction to changes in agricultural development. Statistical instruments such as regression analysis, coefficients of variation ( $v$ ) and the coefficient of determination ( $R^2$ ) and  $R^{-2}$  are the primary statistical instruments for giving empirical content to economic relationships in agriculture. Significance testing provides a procedure to judge if there are any statistical differences between the estimated parameters and the

hypothesised values for population parameters. These statistical analysis tools are used because many economic relationships postulate that changes in one variable can be explained by changes in several other variables such as input prices, technology, climate and commodity price expectations as well as demand and supply responses (Tweeten, 1989:12).

## **1.7 STUDY OUTLINE**

This research is divided into nine chapters. Chapter 1 provides the objectives of the study (main and specific objectives and the purpose of the research), hypothesis, statement of the problem, scope of the study, methodology and the study outline. Chapter 2 deals with identification of variables for economic growth. Chapter 3 provides a review of agricultural growth in Bophuthatswana up to 1991. Chapter 4 describes the agricultural development policy. Chapter 5 describes the methodology of domestic resource cost benefit calculation. Chapter 6 consists of data collection procedures. Chapter 7 deals with the mathematical/econometric model formulations. Chapter 8 presents the empirical results and discussions. Chapter 9 presents the summary and recommendations.

## **CHAPTER TWO**

### ***IDENTIFICATION OF VARIABLES FOR ECONOMIC GROWTH***

#### ***2.1 INTRODUCTION***

For the analysis of the role of agriculture in economic development a theoretical basis should exist. Therefore, the major purpose of this chapter is to review briefly some aspects of some of the underlying theories and models of agricultural sector analysis to identify the main variables for economic growth in this sector. At the same time the foundation for an economic model of production is specified. This is done by scanning the following interrelated areas:

1. variables from formal economic growth models and theories of agricultural development;
2. foundations of economic models and its application to livestock development;
3. the role of research in the economic development process;
4. approaches to empirical measurements in the agricultural sector;
5. different approaches to the analysis of agricultural development, and
6. the conceptualisation and classification of technology with the emphasis on production and resource use.

#### ***2.2 IDENTIFICATION OF MAIN VARIABLES TO DETERMINE ECONOMIC GROWTH THROUGH THE AGRICULTURAL SECTOR***

##### ***2.2.1 Variables from growth models***

###### ***2.2.1.1 Swarn and Rawat growth model***

A point of departure for modern agricultural growth is provided in the Swarn and Rawat (1991:123) growth model. This is a simple model which is based on rather strong assumptions about the economic growth process. The model requires that the total area for cultivation should be increased. The increase of production should be mainly from the area under cultivation for food grains. The consequences of this

assumption is that food grains and food production would increase as result of using land more intensively.

Various authors, for example Raisuddin and Mahabub (1991:4) and Dent and Jones (1991:362) have also recognised that the agricultural sector constitutes the starting point of basic economic development and have indicated that the contribution of agricultural production to the economy depends on the amount of resources used in the production process of new products and services.

#### ***2.2.1.2 Teotônio growth model***

Following Teotônio (1984:1) a formal model of agricultural growth should include elements such as the control of inflation, the balance of payment deficits, efficient supply of food in both internal and external markets, creation of job opportunities and minimisation of unemployment. In the same way, Levin (1989:14-15) argues that the way in which employment opportunities should be created could be analysed in a formal model of agricultural growth to promote both the agricultural and nonagricultural sectors of the economy, to help maintain the real growth rates of the economy and to increase the real *per capita* growth in the economy. Levin also said that one of the negative effects of lower growth rates of the economy is that it is incapable of accommodating new entrants to labour markets.

#### ***2.2.1.3 Arnold and Benneth growth model***

Another formal model of economic growth is found in the Arnold and Benneth (1991:403) study on cattle breeding. Their approach provides for cattle growth models to simulate the beef production enterprise and biological processes. These models were developed to investigate different variables such as digestion, metabolism and nutrient partitioning. Each of these models were expected to provide different results when used as a submodel of growth for a production system.

#### ***2.2.1.4 Various inputs***

According to Evans and Ngau (1991:520) farmers can raise their productivity, output and potential earnings in different ways. They can plant more land, switch from subsistence farming to higher value cash crops, purchase more inputs, hire additional labour or equipment and market a greater part of the commodities, rather

than keeping it for home consumption. This partly supports the Swarn and Rawat viewpoint, but in each case of these actions, financial risk is involved.

#### ***2.2.1.5 Financial facilities***

The provision of financial facilities in agriculture may serve as an additional source of funds to enable farmers to use modern production methods. Financial services to farmers should be broadened according to information on the customers' reliability, cash flows and savings potential (Van Zyl, 1992:40). Social justice towards the financial facilities in the agricultural sector is needed, because the agricultural sector provides simultaneously for the production of food and its distribution leading to growth in the national economy (Erskine, 1990(b):38). This implies the consideration of the financial needs of all the participants in the agricultural sector (Van Zyl, 1992:40). The generation of financial facilities is partially determined by the ability of people in the rural areas to save. It should not be underestimated in spite of the harsh conditions they often have to face.

#### ***2.2.1.6 Change in attitudes***

A new attitude to the development of the agricultural sector is needed for the creation of wealth in agriculture. This needs a change in behaviour and attitudes on the part of the public and private sectors as well as the rural people who should benefit more from such a change (Erskine, 1992:38).

#### ***2.2.1.7 Incentives***

An alternative theory of growth by Shand and Kalirajan (1991:277) which includes "Hirschman's theory of growth" states that substantial incentives should be given to farmers to encourage productivity. This includes amongst other things the supply of cheap inputs or even provide it free of charge. The theory is focused on the "forward linkage" principle of the policy-makers in stimulating greater application of modern inputs by the farmers. This approach supports the approach of Evans and Ngau partly and is also related to the availability of financial resources.

## **2.2.2 Variables from theories of economic development through the agricultural sector**

Following the brief review of the formal economic growth variables as provided in section 2.2.1.4 to 2.2.1.7, this section presents a brief description of the theory and some relevant opinions of economic development through the agricultural sector.

### **2.2.2.1 Neo-classical theory of development**

The neo-classical theory of development used technical progress as a source of growth.<sup>4</sup> According to Jameson and Wilber (1979:12-13) the neo-classical theory of development seems to indicate some success in raising growth rates of the GDP, but its strategy of economic development has failed in some crucial areas of the economy. Moreover, there is continued unemployment, increased income inequality within and among nations and the stagnation of real income levels among the poorest people.

### **2.2.2.2 Modern theory of development**

In this theory of development and growth, population increases and capital accumulation were the sole factors causing economic growth (Jameson and Wilber, 1979:12-13). But, following Mullins and Myburgh (1988:71) the growth rates in the other factors of production, such as entrepreneurial ability, should also be considered. The rate of increase in the population is mainly determined by its natural growth rate and needs to be controlled. Therefore, if the population grows faster than the rate at which the economy can grow, economic growth of a country cannot be sufficient to provide for an increase in the well-being of its inhabitants. In this approach the agricultural sector does not receive any special attention as a factor in economic development.

### **2.2.2.3 Agricultural growth-oriented theory of development**

The agricultural sector was given the role of fuelling the industrialisation process by providing benefits over a wide front to enable the national economy to grow (Arnon, 1987:5). In such a case the development of the agricultural sector plays a pivotal role in the upliftment of the depressed rural areas, in which rural industrialisation should be promoted at the same time, given that the interactions between the

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4 Discussed by Jameson and Wilber, 1979:12-13.

agricultural and non-agricultural sectors can speed up the development process (Erskine, 1992(a):37). Following Erskine (1992(a):38) another most successful method of growth-oriented economic development has been an increase in the agricultural exports production.

#### ***2.2.2.4 Development theory through investment***

As a key aspect to economic growth and development, investment in the agricultural sector has been ignored by many people (Jameson and Wilber, 1979:14-15). The problem of inequality in income and the poor living conditions in the rural areas could be dealt with by directing resources to investment in the agricultural sector.

Development is concerned with the evolution of the social system of production by means of accumulating wealth, and where technological progress becomes more efficient, with increasing productivity of the labour force as a whole (Furtado, 1979:41). This can be linked with the ideas in paragraph 2.2.7 which encourage farmer's incentives for productivity. Meanwhile Furtado considers the concepts such as "efficiency" and "productivity" as ambiguous especially when applied to complex production systems in which inputs and outputs are heterogeneous and vary over time for both the subsistence and commercial agricultural sector.

An efficient and productive farmer tends to use more technology for production as a means of capitalising agricultural activities. Some development thinking (e.g. Folke, 1978:16) considers overcapitalisation of agriculture as a self-sufficient process, because it promotes growth in the agricultural sector and the economy as a whole. Undercapitalisation of agriculture produces all the opposite consequences such as an undersupply of food, rising food prices and pressure on foreign exchange earnings to import food.

#### ***2.2.2.5 Development theory in the Southern African context***

There is a great difference between the development model of the modern and subsistence agricultural sector. The nature of the linkages between the modern and traditional sectors of development has not been adequately addressed by applications of the orthodox neoclassical development theories in the Southern African context (Low, 1982:49), because of the existing disparities between market and non-market factors in the development equation.

Although the neoclassical development theory has succeeded in raising growth rates of some sectors of the economy, its strategy of development has failed in some

crucial areas of the economy, such as at household economics development (Jameson and Wilber, 1979:12-13).<sup>5</sup>

In the application of orthodox development theory in the Southern African context, many authors caution against the land tenure systems in Southern Africa (Low, 1982:49-50; Fenyés, 1988(b):569-570; and Erskine, 1992(a):38). They have focussed their attention generally on the low population densities in African countries on the one hand and on the other hand the land tenure system of the small farmer (communal ownership of land) where there is no landlord tenant system. According to Erskine (1990:19 and 1992(a):38) land tenure systems have been the most crucial constraint for real economic growth and development of the Southern African countries.

#### **2.2.2.6 Theory of household economics**

Economics has been fundamental in providing knowledge and an understanding of the production system, means of production, distribution and consumption of goods and services. Many books on economic studies provide an understanding of the individual firm or household. Following the literature survey, there is no doubt that the modern theory of household economics might have originated with the study of Becker (1965:493-517). The approach followed by Becker (1965:493-517) represented a fundamental reformulation of the theory of consumer choice. The essence of this reformulation means that consumers do not directly maximise their utility by consuming the best combination of goods, but that there is a two stage process involved (Low, 1982:17). In the first stage, the household utilises goods as inputs in a production process to generate more goods. In the second stage, consumers select the best combination of the basic goods in the conventional way in order to maximise their utility function.

In this process the time that is allocated by the household members on income earning or non-income earning activities would become an integral part of economic analysis. This approach would include the applicability of the economic theory of choice into the non-market related sector and would make the theory more relevant in studying the behaviour of the household in its various dimensions (Low, 1982:19).

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5 See also paragraph 2.2.2.1.

### ***2.2.2.7 A model of the traditional farm-household in Southern Africa***

The discussions on this model are based on the current farm-household theory of development which emphasises equilibrium analysis, since household economics form an integral part of the model.

It could be expressed as a subjective equilibrium theory of the farm-household that has not been appropriate under the Southern African conditions. However, the original theory of a peasant economy has been the most appropriate elsewhere in Africa, and could be considered to be equally valid for the Southern African traditional farm-household conditions (Low, 1982:78).

In this original theory of peasant economy, it is understandable that each peasant farm-household works up to the point where its objective analysis of the marginal disutility of work equals its estimate of the marginal utility of the output obtained. The consequence of this situation is that the traditional farm-household production do not change, but the basic consumption requirements do change. The ratio of farm production to basic consumption requirements will generally fall as a result of an increase in the size of the household (Low, 1982:93).

### ***2.2.3 Other variables to consider in agricultural growth***

Given the above theory of development and growth, a realistic approach to agricultural development has to be based on increased agricultural output through the use of more relevant variables. It is only by understanding the use of more relevant variables according to Shand and Kalirajan (1991:278) that a set of choices could be provided for increasing the role of the agricultural sector in the development process. The development of the agricultural sector has a remarkable impact on the socio-economic conditions of the population, on the earnings of the farmers, stabilisation of agrarian markets and prices as well as a stable supply of the agricultural products at a reasonable low price (Weidmann, 1990:8).

Investigation into Zaire's agricultural sector has shown the need to improve the administration of the farmers and reform their systems of production in all aspects. This contributed effectively to the development of the agricultural sector for economic growth and development of Zaire (Kongolo, 1987:6-7). In the same way,

Kongolo concluded that Zaire's agricultural economy needed transformation from a traditional rural into a modern agricultural sector.<sup>6</sup>

Given the above theoretical analysis and practical background, the main elements to consider in a growth model for agricultural development are the following:

### *2.2.3.1 Quality of land*

The quality of land has to be considered from the viewpoint of good and poor quality. From the viewpoint of economic reality agricultural production in African countries, many people occupy small pieces of poor land in low rainfall areas which can never be economically viable for agricultural production. People with such limited opportunities could move and seek employment in urban areas or they can develop home industry skills and then enter the market economy (Erskine, 1990:21).

Erskine's underlying assumption of moving to seek employment in urban areas has been the main object of criticism by Wilber and Jameson (1979:15). The argument of their objection is that this type of approach to agricultural production for the development of the region cannot succeed, simply because the poor rural people will move into the cities in far greater numbers than that assumed by the theory. The demonstration effect of urban life has always been a major centrifugal force in drawing people from the rural to the urban areas. This could be inhibited by encouraging agricultural production and the development of rural areas, because living in urban areas does not guarantee an improvement in the living standards and quality of life.

Erskine (1990:21) concludes that rural people with access to good land and water could be encouraged to enter the market economy as smallholder farmers, but what these people will need is an appropriate structure to strengthen their role and activities as small farmers.

### *2.2.3.2 Institutional change*

In order to achieve a better quality of life of the farm population and to contribute to rural welfare, Sculli (1980:3) suggests that institutional change through better advice to farmers could increase agricultural production. This type of advisory work will have an economic and social objective as explained in the following paragraphs:

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6 Following Schultz, 1966:278-283.

1. The economic objective is to increase the agricultural productivity by promoting economic progress and the optimal utilisation of all the factors of production (land, labour, capital and management).
2. The social objective is to help farm families to improve their quality of life and to achieve their social aspirations. This will enable them to make the necessary adaptation to the changing society in which they live and work.

Institutional change in agricultural production is a process of conscious transmission of knowledge, facts and objective judgements on agricultural matters to the farmers, the farming population and other concerned with agricultural production (Sculli, 1980:4). This process enables farmers to make sound decisions with regard to the improvement of farm productivity and farm welfare in general. To reach these objectives, a good rural infrastructure is needed.

### *2.2.3.3 Rural infrastructure*

The rural infrastructure is a link to economic growth because its role is to alleviate poverty of the rural households through a range of potential effects on the agricultural production systems, e.g. employment, household incomes, food consumption, investment and saving behaviour, the market and the social development of the people (Raisuddin and Mahabub, 1990:24).

Rural infrastructure could be used by both the agricultural and non-agricultural sectors in order to expand the agricultural and industrial sectors in the rural areas. This effect is usually accompanied by the increase of rural incomes which represents a major potential market for consumer goods. At the same time big producers can become big consumers, a process which can contribute decisively to overall economic growth for sustained development (Erskine, 1992(a):37).

Fair and just agricultural development needs the provision of both the production and distribution of resources for economic growth. Rural infrastructure could provide rural labour with good opportunities for earning non-farm income which would contribute substantially to a more equal income distribution between the rural and the urban families (Erskine, 1992(b):38). This will enable families to raise their living standards and to invest in the rural areas. This should also have an impact on the land tenure system.<sup>7</sup>

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<sup>7</sup> Discussed also in 1.3.3.

#### 2.2.3.4 *Land tenure systems*

There is no doubt that one of the crucial requirements for a real economic growth in the rural areas is land as a resource. A land tenure system has been one of the most sensitive issues which needs immediate attention (Erskine, 1992(a):38). The distributional land tenure system is the major cause for the investment and development gap between the rural areas in Africa. The traditional land tenure system which is characteristic of the African rural areas is generally regarded as the most serious obstacle holding back agricultural production. Therefore, formalisation of the indigenous land tenure system is needed to allow for the sale, exchange and lease of the land itself, and separate user rights (Erskine, 1990:19). This would be the best way to progress towards a freehold land tenure system which encourages agricultural production and the development of the rural areas.

The process of identification of variables often leads to model formulation so as to facilitate an economic analysis of the variables identified. The following section discusses the formulation of an economic model.

### 2.3 *THE ECONOMIC MODEL*

#### 2.3.1 *General considerations*

The argument that the agricultural sector has a key role to play in supporting the domestic economy to grow has been forwarded and discussed by many authors.<sup>8</sup>

This is understandable because of the relationships and multipliers between food supply, rural purchasing power, labour and the capital linkages in the process of economic growth. Food production provides great opportunities to support increased employment and wage earnings, consumer goods and the production of other goods and services in the domestic economy (Van Rooyen and Machethe, 1991:176).

It is commonly accepted that agricultural development could be possible by:<sup>9</sup>

1. bringing more land under cultivation and/or
2. increasing productivity per unit of land.

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8 See Tshibaka, 1986:15; Van Rooyen and Machethe, 1991:176.

9 See Arnon, 1987:25.

The economic model will follow the second way, because it is entirely dependent on the application of improved farming practices which can lead to an efficient agricultural sector for economic development of the country. The components of economic efficiency of the farmers can be estimated and analysed using a production function approach (Nelson *et al.*, 1991:1482). Following this reasoning, the conceptual approach of the production function based on the different assumptions is developed in the next section.

### 2.3.2 Description of the production function

In a broad sense, a production function may be defined as an expression of the transformation of inputs into outputs, and where technology represents a set of technical opportunities that define the basic relationships of this transformation (Heady and Dillon, 1972:20-45).

The process of transformation may be considered through the use of a vector of input-output coefficients. This is a particular method or technique of converting resources into products, and where technology represents a complete set of processes available or potentially available for production. An agricultural process can be defined as the different ways or sequences in which agricultural production can be carried out. It is characterised by certain ratings of the quantities of inputs to each other and to the quantities of each of the outputs (Day, 1963:61-62).

Mathematically the production function can be represented by equation (1):

$$Y = f(x_1, \dots, x_j / x_{j+1}, \dots, x_n) \quad (1)$$

where:  $y$  = output

$x_1, \dots, x_j$  = variable inputs, and

$x_{j+1}, \dots, x_n$  = fixed inputs.

Equation (1) may also be written to provide equation (2):

$$Y = f(x_1, x_2 / x_3, x_4, \dots, x_n) \quad (2)$$

where:  $x_1, x_2$  = variable inputs, and

$x_3, x_4, \dots, x_n$  = fixed inputs.

Specification of the variables in a production function and the form of the function is based on the nature of the production process described by the function. A

complete specification of the relationships between inputs and outputs defines a function or surface in the case of more than one variable input.

Changes in the quantity of variable factors will define the movement along the production function or surface. This movement would define the trend of production (upward or downward) depending on the nature of the change (Henderson and Quandt, 1980:69-84).

### 2.3.3 *Specification of the production function*

In this study, resource allocation is represented by using a Cobb-Douglas production function. This technique in its log-linear form was used by Nelson *et al.* (1991:1482), when they used a model of the production components of limited resource productivity of farmers in Georgia. The framework in which the models are cast follows that used by Kongolo (1984:13-15) in estimating a maize production function in the District of Kipushi, region of Shaba, Zaire. The model specification is given by equation (3), which treats the total production as a total supply by involving dependent and independent variables in the production process expressed in logarithmic form of function (3).

$$Y = AX_i^{b_i} \quad (3)$$

where:  $y$  = output

$i = 1, 2, 3, 4, \dots, n$ ;

$x_1$  = area cultivated in (ha);

$x_2$  = labour;

$x_3$  = capital;

$x_n$  =  $n$  factors of production used;

$b_i$  = regression coefficients, and

$A$  = constant.

To determine combinations that would maximise the production of  $Y$ , it is important to know the corresponding prices of the different inputs used in the production process. Assuming that the maximisation conditions are satisfied, the allocative efficiency would be expressed by equation (4), which describes maximisation of  $Y$  (output) by equalising individual marginal productivities divided by the corresponding price.

$$\frac{Mp_{x1}}{P_{x1}} = \frac{Mp_{x2}}{P_{x2}} = \frac{Mp_{x3}}{P_{x3}} = \dots = \frac{Mp_{xn}}{P_{xn}} \quad (4)$$

where:  $Mp_{x1}$  = marginal productivity of  $x_1$ ;  
 $x_1, x_2, x_3, \dots, x_n$  = variable inputs, and  
 $P_{x1}$  = price of input  $x_1$ .

According to the theory of production economics, the maximum quantity of output Y to be produced is given by equation (5):

$$\frac{MP_{x1} \cdot P_y}{P_{x1}} = \frac{MP_{x2} \cdot P_y}{P_{x2}} = \frac{MP_{x3} \cdot P_y}{P_{x3}} = \dots = \frac{MP_{xn} \cdot P_y}{P_{xn}} \quad (5)$$

where:  $Mp_{xi}$  is the marginal productivity,  $i=1,2,3,\dots,n$ ;  
 $x_i, \dots, x_n$  are variable inputs;  
 $P_{xi}$  is the price of input  $x_i$ , and  
 $P_y$  is the price of output  $y_i$ .

A point could be made that when resources are unlimited, one cannot reach the requirements of equation (5). But when the resources are limited, the maximum level of output could be determine as given in equation (6).

$$\frac{MP_{x1}P_y}{P_{x1}} = \frac{MP_{x2}P_y}{P_{x2}} = \frac{MP_{x3}P_y}{P_{x3}} = \dots = \frac{MP_{xn}P_y}{P_{xn}} = K \quad (6)$$

where:  $K > 1$ , and represents a constant.

The process followed was to multiply the marginal productivity by the corresponding price of the output Y (Nelson *et al.*, 1991:1483). This was done in order to determine the marginal value product (MVP) of the inputs and the cost of output. Mathematically this is expressed in equation (7):

$$MP_{xi} \cdot P_y = MVP_{xi} \quad (7)$$

Equations (3-6) could be transformed using the marginal value product (MVP) as expressed in equation (7) in order to reach equation (8):

$$\frac{MVP_{x1}}{P_{x1}} = \frac{MVP_{x2}}{P_{x2}} = \frac{MVP_{x3}}{P_{x3}} = \dots\dots\dots = \frac{MVP_{xn}}{P_{xn}} = 1 \quad (8)$$

Equation (8) indicates that the quantity of investment for agricultural production should be increased until its marginal value product (MVP) would be equal to its marginal cost. However, if additional production has been obtained by an increase in the quantity of input  $x_1$  and its price  $P_{x1}$ , this implies that its marginal cost would be expressed as given in equation (9):

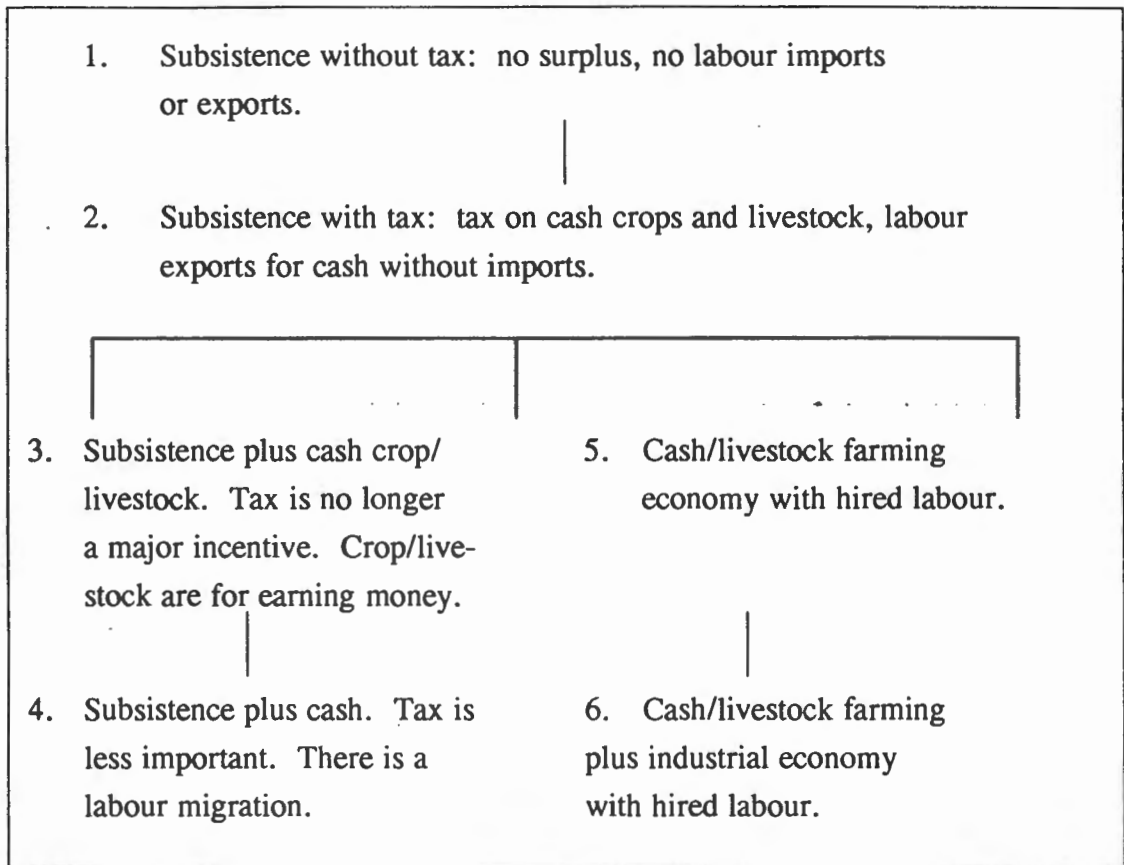
$$MC_{xi} = \text{roman } \Delta_{xi} P_{xi} \quad (9)$$

where:  $\Delta_{xi}$  represents the unit in which the increase of factor of production is measured, and in which its marginal cost equals its price. Furthermore, if  $MVP_{xi} > MC_{xi}$ , this implies that  $xi$  needs to be increased in the production process. But if  $MVP_{xi} < MC_{xi}$ , the use of  $xi$  depends on the income possibilities to increase productivity.

Given the optimisation technique above, the stage of agricultural change leading to a "take-off" in economic growth could be provided by following an economic model to promote agricultural growth for economic development in the area of study.

#### 2.3.4 Formalisation of an economic model for agricultural change

Stages of agricultural change from subsistence to a cash crop and livestock economy could be shown as presented in figure 1:

**FIGURE 1: The stages of agricultural change.**

Source: Adopted from Fenyes (1982:52).

Evidence from the survey has clearly shown that the majority of small farmers in the area of study obviously fall between stages 3 and 4 of agricultural change.

The modernisation process in the economic model is presented in this section following Mosher as quoted by Arnon (1987:17). Different facilities and services involved in modernisation of the agricultural sector have been classified in two main groups, namely essential variables for innovation and accelerators.

The essential variables for innovation which must be present following Arnon (1987:7) are:

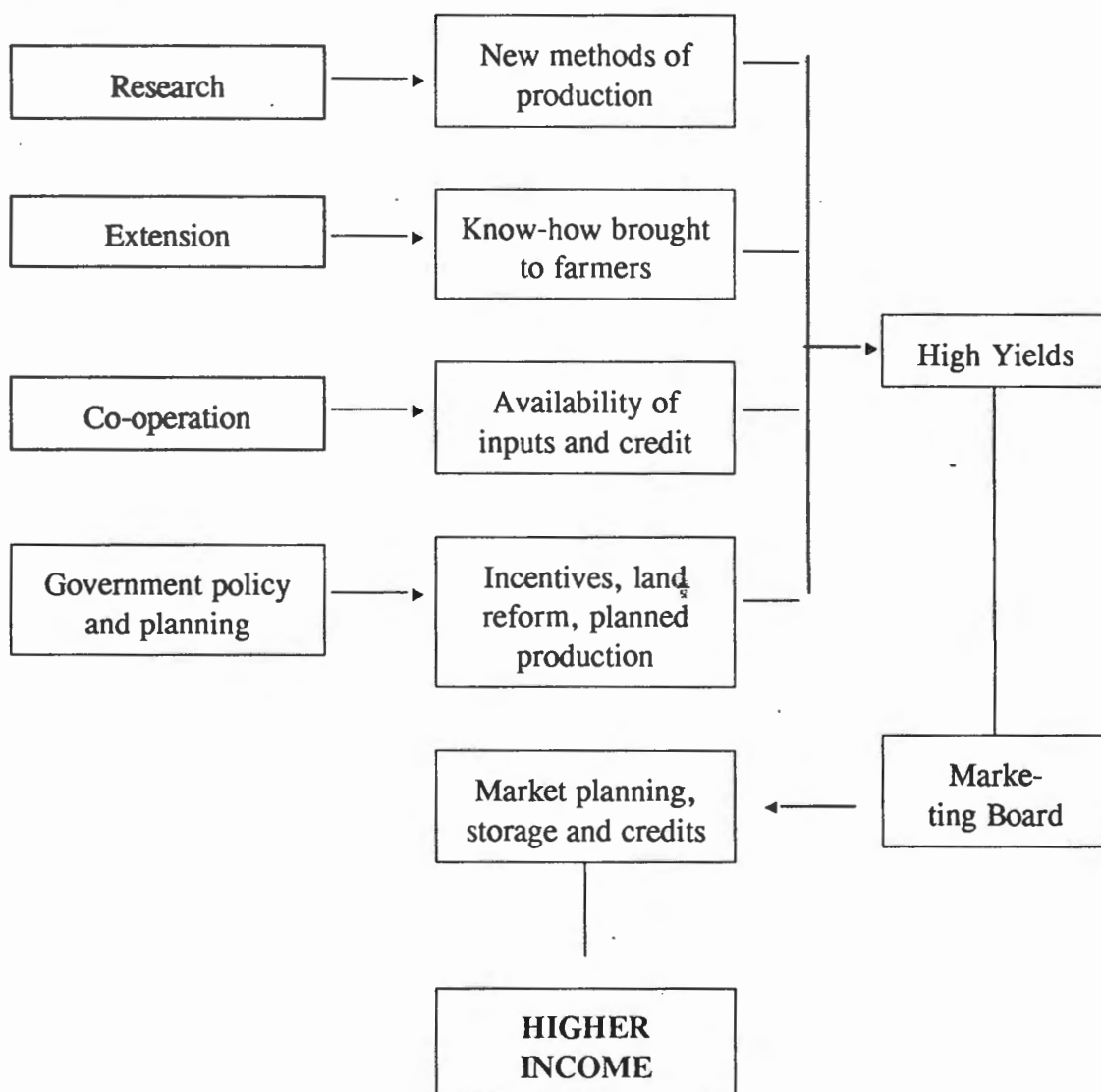
1. markets for farm products;
2. constant improvement of technology;
3. local availability of supplies and equipment;
4. incentives, and
5. sufficient transport.

The five accelerators include:

1. education for development;
2. credit availability;
3. group actions by farmers;
4. improving and expanding the agricultural land, and
5. national development planning.

Given the above conditions and accelerators, the proposed economic model for promoting the agricultural development for change could be summarised as provided in figure 2:

**FIGURE 2: An economic model of agricultural change.**



Source: Adopted from Arnon (1987:19).

Figure 3 presents an economic chain of simultaneous activities and events which can lead to agricultural growth to achieve increased and higher incomes of farmers. In this figure, the combination of explanatory variables such as research, extension, co-operation among departments and individual farmers as well as government policy and planning, would result in new methods of farming practices, know-how of the production process with availability of inputs and credit facilities and government participation in terms of incentives for the production and planning process of the production system.

All these elements combined together with an effective agricultural development policy will result in high yields in the agricultural sector. These yields will therefore increase agricultural productivity, which would explain increases or changes brought about in the agricultural sector.

In order to achieve higher income for the farmers, potential markets for agricultural commodities, planning and storage facilities should exist. This is mainly the task of the Marketing Board. The formulation of such an appropriate strategy to promote growth in the agricultural sector must be planned for implementation. In the same manner, all decisions on strategy, including its priorities, must be taken while economic and social consequences of these decisions and priorities should be anticipated.

Given the above explanation as an example, a model for livestock development in the area of study is provided with the emphasis on carrying capacity, stocking rates, overgrazing and overstocking. The selection of livestock was mainly based on its contribution to GDP of the area of study on the one hand and on the other hand, livestock farming has been one of the most important agricultural activities for both men and women in the same area.

## **2.4 A MODEL FOR LIVESTOCK DEVELOPMENT IN THE AREA OF STUDY**

### **2.4.1 Carrying capacity**

Similar to the improvement of the crop-farming system, the development of livestock in the area of study was critical for improving rural productivity and welfare. Cattle raising has traditionally been a major economic activity since limited soil potential and rainfall have precluded crop production in some areas of the country. In many of these pastoral areas livestock development has been the only means of raising the living standards of the rural communities.

In the non-pastoral areas studied, stock raising has been an effective complement to crop farming. An improved planting method could provide increased supplies of fodder for livestock, which in return could increase the dairy and meat products for consumption (Lele, 1975:56).

Livestock development in the area of study reached a critical stage, because stock is actually beyond the required carrying capacity (De Smidt, 1992:16; Coetzee, 1992:20). The potential grazing area in the area of study was almost 3,4 million hectares (Department of Agriculture and Natural Resources, 1991:30). If an average of 12 hectares can be used per one mature livestock unit (M.L.U.), the total number of livestock in the area could be almost 300 000 heads. The livestock census in 1991 has revealed that there are about 50 % more animals in the area studied than the estimated carrying capacity (see Table 2 which summarises the findings of the census).

**TABLE 2: Summary of findings on livestock census in Bophuthatswana, 1991.**

Cattle	Sheep	Goats	Horses	Mules or Donkeys	Pigs	Dogs	Poultry
455343	53061	87015	26087	34848	12836	41885	260035

Source: Department of Agriculture and Natural Resources (1991:26).

The data provided in table 2 exclude the number of livestock units from the Agrichicks and Mimosa West Farm. The number of the animals provided by the farmers was about 90% of their actual stock. This because farmers were not able to bring all their animals to the places where census data was collected.

#### **2.4.2 Stocking rates**

Bophuthatswana is predominantly suited for animal production but the actual stocking rates have already exceeded it's estimated optimum capacity (De Smidt, 1992:16). The question to be addressed is whether the livestock industry in this area was going to develop in such a way that a stable limit is maintained over time which might be expanded slightly with better management practices, or whether growth in livestock was going to be characterised by a downward spiraling ratchet effect. In the latter case, the herd will grow initially, but due to overstocking, the number of animal deaths will increase and growth rates will decline. The ratio of livestock to

land resource could then become favourable again. Then the herd could increase and finally the cycle could be repeated once more (World Bank, 1983:13).

In reality, the government could do little to avoid the possible negative ratchet effects over the next number of years if the country has not already begun to implement the necessary adjustment measures. The problem arises essentially from the communal and tribal grazing system, in which the land is treated as a free resource. This problem is not likely to disappear until the land issue is dealt with.

### **2.4.3 *Overgrazing and overstocking***

Since (overgrazing) overstocking has been identified as the single most important problem facing the livestock industry in the area of study, many attempts have been made with the problem because it is destroying the natural grazing (Crossly, 1992:1). Most of these efforts failed because policies for controlling the overstocking have been in conflict with individual livestock owners. A good understanding of the objectives of livestock owners to keep their animals is important to achieve the objective of reducing overstocking in the area of study (Crossly, 1992:1).

Although "a take-off" in the agricultural sector is needed as it determines the first essential steps for self-sustaining economic growth, people always need a development model that would assist them in minimising the cost of such development to maximise their profits (Arnon, 1987:17). The economic model developed in section 2.4.3 has used the Cobb-Douglas function in the case of crop production since the inputs are measurable. In the case of livestock the approach has to be changed because growth in livestock is influenced by different variables with only some of them that could be measured.

The application of these models could be tested by relevant agricultural research and other aspects of the agricultural development process as discussed in 2.7.

## **2.5 *THE ROLE OF RESEARCH FOR AGRICULTURAL DEVELOPMENT***

Agricultural development research has been an important activity to solve farming problems. It should be production oriented using improved methods and practices that are not expensive, labour saving, dependable and predictable to all farmers (Tire, 1991:7). There is a growing belief (Tire, 1991:1) that agricultural development research conducted during the past years benefited mainly large-scale

farmers of the area of study. In contrast, farmers with limited resources failed to use the same opportunities because of their socio-economic constraints.

Various authors (e.g. Schultz, 1985:25; Tire, 1991:1-2 and Norton and Ortiz, 1992:203) describe the primary objective of agricultural development research as to increase productivity of the farming systems. Also it is an investment in future productivity and income growth for economic development. Meanwhile, Ntseke (1993:1) considers agricultural development research as one of the key elements in bringing significant improvements in any established agricultural sector.

Increased attention is also given to the role of research in the process of agricultural development by Schultz (1985:25). He argues that research is an important element in the process of modernisation of agriculture which will have a direct influence on the future food supply.<sup>10</sup> Agricultural development research has an important role to play in designing technical and institutional solutions to food safety problems.

The economic aspects of the agricultural development research, including methodology, the decision-making process, welfare implications of agricultural development and changes are discussed by Schultz on a conceptual basis.<sup>11</sup>

Agricultural development research is treated as an economic activity, because it requires scarce resources and it also produces something of value (Schultz, 1985:25). It is a specialised activity that needs special skills and facilities that are used to discover and to produce new and presumably useful information on the agricultural development process. According to Bunting (1985:8), agricultural development research provides sufficient information on the existing state of agriculture in the region and the knowledge of what to produce at least in the short term. It is used as an approach to the solutions of agricultural development for stable economic growth.

Research is cardinal for the progress of every branch of the economy including agriculture. This is substantiated by a close correlation between the quality and quantity of agricultural development research and the state of agriculture in the country (Sculli, 1980:199), but it should not be considered as an end in itself, for it's purpose is to discover solutions of practical value and appropriate methodology

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10 See e.g. Ntseke, 1993:1; De Lange, 1993:1-2 and Kongolo, 1993:9.

11 See also Sculli, 1980:22; Duvel, 1993:2 and Ferreira, Meynhardt and Dafel, 1993:2-3.

of agricultural development. Section 2.8 discusses various approaches to empirical research analysis.

## **2.6 APPROACHES TO EMPIRICAL MEASUREMENTS IN AGRICULTURE**

A great variety of approaches to the empirical measurements of returns on agricultural production exist. In this section, some of the most useful approaches are discussed.

### **2.6.1 Harberger's approach**

A point of departure is given by Harberger (1979:45) who uses the "perpetual inventory technique". This approach consists of separately calculating the value of the agricultural assets used in the production process.<sup>12</sup> In this approach the problem is to determine gross investment in the agricultural sector.

### **2.6.2 Haggblade *et al.* approach**

Haggblade *et al.* (1991:361-362) have made use of "fixed-price models" to estimate the contribution of agricultural productivity to national economic growth. Their approach classifies agricultural activities as into tradable and non-tradable goods according to the region's trade in possibilities with the larger national and regional economy. For African rural regions, agricultural food grains or cash crops usually are the major tradable commodities. The non-tradable products often include perishable agricultural commodities. From the point of view of fixed-price models, increased agricultural productivity of tradable commodities is viewed as the driving force in regional economic growth.

### **2.6.3 Cost-benefit approach**

Cost-benefit analysis has also been widely used to study returns and welfare effects of investments on agricultural production and training (Botha, 1991:1).

This approach uses a partial equilibrium technique based on the concept of economic surplus. The pioneer work in this area was provided by Griliches (1958:419-431) when he calculated the rate of return on agricultural research by estimating the loss

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12 See also Tweeten and Hines, 1965:40-45.

in consumer surplus to society that would occur if the hybrid corn had not been developed. In the same way, Kirsten and Van Zyl (1991:209-210) used this technique to study the economic viability of water projects. It has a one-dimensional criterion which concentrates on increasing national income through increased efficiency and agricultural productivity. The distribution and equity considerations are ignored in the model and are said to be secondary to the efficiency objective.

#### ***2.6.4 Houba and Kremers' approach***

Houba and Kremers (1991:1103) have used the cost-benefit approach to estimate the contribution of agriculture to national economic growth, though in a different context. In their ideas, they have suggested that the dynamics of input-output analysis could be combined with the components such as supply, final demand for intermediate goods and the demand for capital goods in the process of economic growth and development.

#### ***2.6.5 Impact analysis approach***

An impact analysis approach has also been successfully used in agricultural sector analysis. Mentza *et al.* (1987:153-154) for example, are of the opinion that input-output analysis is an important technique because it takes inter-sectoral transactions into consideration to provide more detailed impact results. Its characteristics have resulted in the widespread use of this growth model in the analysis of the agricultural sector. Therefore, input-output analysis is an ideally suited approach for agricultural sector analysis.

#### ***2.6.6 Aggregate production functions and regression analysis approach***

This has been another way to study the contribution to productivity in agriculture. Griliches (1964:961-963) uses this technique in an attempt to estimate the marginal returns to agricultural production by utilisation of the data on agricultural expenditure as an explanatory variable. Johnson and Baum (1986:2-6) use the same basic idea, but attempt to extend their analysis to the agricultural expenditure approach of Griliches.

### 2.6.7 *Furtado's approach*

Furtado (1979:145) analyses economic progress in Brazil by the economic surplus concept, but then goes on to evaluate benefits of income distribution as an indication of economic growth of the country as a whole. Furtado considers a more normal distribution of income as one of the basic conditions for economic development, which will include growth in consumption and better standards of living for every person.<sup>13</sup> In view of the increased public concern over income distribution in the Zona da Mata, Minas Gerais, Brazil, the importance of income distribution for the development of the Zone was investigated (Kongolo, 1985:25-35). To determine social welfare information is needed on the functional and personal distribution of income. However, a study by George *et al.* (1981:18-19) has attempted to extend the analysis of income distribution of farmers and food problems among people. Their approach has been based on the economic growth concept in which the production surplus and benefits from income distribution was analysed.

### 2.6.8 *Stochastic dominance approach*

The study by Bishop *et al.* (1991:936) uses this approach to investigate income distribution effects of the recent growth and recession on the income levels in the United States. Rather than looking at a single summary stochastic such as *per capita* GNP over time, they have considered the entire income distribution and measured the economic performance by looking at a number of elements within that distribution. In concluding their study, they have assumed that the relationship between income distribution and the standards of living has been summarised within the social welfare function or social evaluation function representing their judgement regarding the distribution of income.<sup>14</sup> On the other hand, Gomes (1984:6-11) has observed that improved income distribution is a process that enriches the local rural people which enables personal development. The distribution of income can, in certain circumstances such as the non-implementation of this approach, generate a disparity of income amongst rural people.

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13 Discussed also by Riemenschneider, 1976:5-10.

14 See e.g. Atkinson, 1970:244-263; Psacharopoulos, 1981:37-54 and Bishop, Chow and Formby, 1991, 54(4):936-946.

### 2.6.9 *General growth approach*

In the underlying debate on income distribution, the study by Bishop *et al.* (1991:936) has revealed that the adverse effects of a recession and the benefits of growth have been widely researched and perhaps generally understood. Their viewpoint on the effects of the low rates of growth based on the income distribution is that they have not been well researched and well understood. They have indicated that the growth rate in the domestic terms of trade between the agricultural and the urban sectors influences the distribution of income among these sectors. Bishop *et al.* (1991:936) have focused their attention on the analysis of income distribution as a principle leading to a general growth model. However, Lele (1985:163-164) concludes that increases in the agricultural growth rates are necessary, given the role of agriculture in the GDP. The agricultural sector constitutes a major source of government revenues. It is important for the government to control agricultural growth rates to generate its income. These revenues could be ploughed back into the agricultural activities to influence growth rates of current and future agricultural production. To understand the role of agriculture for economic development an analysis is needed as provided in section 2.9.

## 2.7 *DIFFERENT APPROACHES TO THE ANALYSIS OF AGRICULTURAL DEVELOPMENT*

### 2.7.1 *Production function analysis*

Heady (1960:25-30) is one of the pioneers to present the techniques of studying production functions and other aspects such as returns to scale and productivity of the agricultural production in its different forms. Heady investigates the possible technical considerations in the study of production, resource productivity and returns to scale by using a quantitative approach. Heady (1960:779-780) uses an input-output approach to estimate the relationship between productivity coefficients in the production process. Plaxico (1968:666-670) also used the same approach as Heady and estimates the values of the factors of production through the use of the Cobb-Douglas production function.

Recently, Shand and Kalirajan (1991:278) made use of the production function analysis technique to investigate the contribution of the Kemubu project to the agricultural growth in Kelantia, Malaysia, by measuring the effects of this project. The units of analysis were classified into different socio-economic groups in order to

have a better view of the effects of the distribution of benefits. The stratification was based on the two main socio-economic characteristics, namely land tenure and the size of the operational area of selected farmers.

### **2.7.2 Programming models**

In investigating food security in Kwa Zulu, Lyne *et al.* (1991:42-48) analyse household-based results by making use of a programming model.

A mathematical programming model of rural Kwa Zulu was developed to simulate agricultural production in the regions of high and low cropping potential. This model aggregates enterprise levels predicted for four representative households of which two were in the high-potential region and another two in the low-potential region. Some economic scenarios were simulated with the model to predict variables such as responses to change in cereal prices, change in input subsidies of off-farm employment and the rental market for crop land.

### **2.7.3 Econometric models**

Swarn and Rawat (1990:121) analyse agricultural production growth in an agricultural project by using econometric models. The results of their study were reflected by the increased agricultural production of the farmers in Haryana region from 60 000 tons in 1980/81 to 81 000 tons in 1985/86. Kongolo (1984:15-18) also presents an econometric analysis of the maize production function in the district of Kipushi, Zaire, in which land, labour and capital were the estimated variables to represent the economic viability of maize production in the district. The main purpose of the analysis was to provide an adjusted production function which shows maize production in the districts and in which the level of significance of all the variables was given.

## **2.8 CONCEPTUALISATION OF TECHNOLOGY OF PRODUCTION**

This section discusses the technology of production following the different viewpoints of various authors.

### 2.8.1 *Distributional effects of technology*

A major gap in the knowledge in the area of investment in agricultural production is the distributional effect of technological change. In view of the increased public concern over development, more information on how to raise agricultural production is needed on the functional and personal economic changes that affect people. Many studies have attempted to extend the analysis of previous research based on the concept of technological change in order to investigate who are the beneficiaries of this process. For example Türe (1991:15) points out that technology developed in other countries has not proved to be worthwhile for the developing countries. These technologies have not been practically adopted in these countries and have failed to bring about expected results.

### 2.8.2 *Integrated concept*

Technological progress is a means of encouraging agricultural production for overall economic development and it cannot be seen in an isolated form of production units (Furtado, 1979:135). However, to raise agricultural production, new technology is needed together with modern farm inputs. Some of these resources can be ordered from other countries, while others should be developed locally (Erskine, 1992(a):24).

### 2.8.3 *Technological adaption*

The model of development by Shand and Kalirajan (1991:277-278) concentrates on technological adaption. They have observed that it is really an endogenous process embodied in the factors of production on the one hand, and on the other hand in the factors of agricultural development.<sup>15</sup> The geographical concentration of economic activities for the benefit of a small part of the population in a country is one of the most striking consequences of the intensification of the accumulation process (Furtado, 1979:144). A large number of the most significant forms of technological progress can be fully grasped only by an overall view of the social system and the nature of its relation, both with the physical environment it controls and also with the outside world.

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15 Also see Solow, 1957:312-320.

#### **2.8.4 *Unconventional variables***

The recognition by Shenggen (1991:266) that the level of technological knowledge depends on the resources allocated to the production of new products to accelerate agricultural production growth, has brought increasing attention to the use of some unconventional variables such as research, extension and education as the major sources of productivity growth. Shenggen believes that rapid agricultural change could be attributed to an increase in outputs, technological and institutional change leading to regional growth. Meanwhile, Furtado (1979:136-137) considers the term technological progress as a vague concept which, in the sense most commonly used, covers all aspects of social changes and which makes it possible for the progress of accumulation to continue. This accumulation process is achieved by transferring to the future agricultural production the practical aspect of technology as a resource to increase agricultural production.

#### **2.8.5 *Mechanical technology and management***

Driver and Onwana (1986:157) discovered that mechanical technology was almost perfectly related to the production systems design, and that the classification of farms by technology of production systems statistically assured homogenous production response potentials within groups of farmers. They finally accepted that the differences between real and potential performance of farmers using the same technology was due to management ability and behaviour. Thereafter, they also observed that management and behaviour affected farmers' choices of production systems, activity combinations and the levels of agricultural production.

#### **2.8.6 *Appropriate technology***

Rose and Tapson (1984:167) prefer technology developed by national research stations because it is used by the business sector with its greater access to the information and adequate economic resources.

Kotsokoane (1993:1) considers this type of technology aptly defined as "simply taking" all the factors of production into account, and being intelligent about the total environment within the problem to be solved. This also supports the same idea by Groenewald and Koch (1989:372) who consider such technology as a means of accelerating agricultural development.

Danckwortt (1989:21) states that technological progress can soon lead to over-development. However, making technology appropriate could improve the levels of development needed in the agricultural sector. He also added that the process of development through technological aid may benefit farmers materially on the one hand, and on the other hand this process can also harm the farmers spiritually (Danckwortt, 1989:21).

### **2.8.7 *Relationship between technology and agricultural growth***

A review of technological change in agriculture gives ample evidence of agricultural development. Farm productivity has increased substantially by innumerable technological innovations which have altered the basic capital-land-labour mix of many farming systems (Sculli, 1980:1). Large movements of manpower from the agricultural sector to other economic sectors have taken place and agriculture has progressively become more capital intensive, while farmers have become more dependent on external capital. The structure of agriculture has changed slowly and the relationships between economic sectors, (national and international) have continually altered. These various changes have necessitated that farmers, farming families and farm workers adapt themselves continuously to new approaches of technology in agricultural development.

### **2.8.8 *Application of technology***

Carter *et al.* (1986:365) recognise that the problem with the adoption of new technology can be seen as a matter of changing the agricultural production process for economic development. They have considered the economic costs and the benefits associated with technological change as the means of boosting agricultural development. Bembridge (1988(b):31) argues that technological change can open new economic opportunities provided that the other necessary institutional changes are made. A strategy for development and transfer of technology must be a dynamic and flexible process to be constantly modified for the needs of the intended households.

According to Van Vuuren (1988:40) the majority of African agricultural development models are often based on the Western agricultural development concept, where the technical know-how and "know-why" is far removed from the own technological apparatus of the African peasant farmers. So often these farmers are described as "backward" and even more, lacking motivation and knowledge.

Although important technological advances have been made by researchers in almost every facet of commercial agricultural production for development, this type of research has not covered all aspects of agricultural production because the relative factors of production and commodity values differ greatly in small-scale peasant agriculture (Bembridge, 1986:27-28).

### **2.8.9 *Interrelationships with other factors***

De Klerk (1990:426) focuses his attention on other technologies as agricultural problem-solving. He then outlined biological, economic and institutional factors that needed to be considered. He also underlined the importance of both efficiency and equity as criteria for the development of the agricultural sector, because these elements constitute the frequent trade-off between these factors and the technology of production used. However, Erskine (1992:24) concludes that technological progress alone is not sufficient to solve the various problems related to the development of agriculture. Normally such solutions should also call for some organisational support in rural areas. Rural organisations cannot emerge spontaneously in response to technological innovations without any support, but they are indispensable to implement any agricultural development approach that could be promoted through a facilitation process.

## **2.9 CONCLUSION**

Any kind of economic sector model must be based on some useful theories of economic development and growth. This chapter presents an overall look at some of the variables in some of the theories, models and principles of agriculture for economic development with emphasis on the modern agricultural growth models, followed by the incorporation of the concepts of formal models of agricultural productivity and technological change. The models presented are in line with the point of view which emphasises the role of agriculture in the process of economic development (Herz, 1989:44), which is a major source of sustaining economic growth by equipping farmers for continued higher productivity. Smallholder agriculture constitutes the core of the African agricultural output, producing almost three quarters of the agricultural products including almost all the food consumed at home. A prosperous smallholder agricultural sector can contribute to economic development of the rural areas (Erskine, 1992(a):23). The smallholder agricultural model of development is aimed at improving both efficiency and productivity in the commercial and subsistence agricultural sector. Technological and institutional

changes can also affect agricultural production in various ways by increasing their outputs. But technological progress alone cannot solve all agricultural related development problems. This will need some other ingredients in a form of organisational support, guidance and facilitation of the process.

Agricultural infrastructure is one of the most important ingredients for the development of the agricultural sector. It can be used by both the agricultural and non-agricultural sectors for increasing rural income which is a major potential market of consumer goods and a generator for employment facilities in the rural areas.

The provision of the models of agricultural development in this study shows how the agricultural sector could contribute to economic growth and development.

The models also represent an attempt to determine the contribution of the development for the rural areas by bringing balanced socio-economic conditions.

A formal model of agricultural growth by Teotônio (1984:1) and by Swarn and Rawatt (1990:123) explains the key role of the agricultural sector in supporting economic growth and development, and could be considered as the basic idea followed in this study. To use these models for the area of study, it is important to know more about the regional economy and how it affects the agricultural production. This constitutes the focus of the following chapter.

## **CHAPTER THREE**

### **REVIEW OF AGRICULTURAL GROWTH IN BOPHUTHATSWANA UP TO 1991**

#### **3.1 INTRODUCTION**

The main purpose of this chapter is to present a review of agricultural growth in the area of study. The first part of the chapter provides macro-economic data on the agricultural economy of the area of study, the domestic income from agriculture and the supply and demand for agricultural products. The second part summarises the characteristics of the agricultural economy with reference to agricultural production, economic growth and development, and the interrelationships among economic activities in the area of study.

#### **3.2 THE GEOGRAPHICAL SETTING**

The former Republic of Bophuthatswana is situated in Southern Africa. The area consists of seven separate geographical units totalling 44 055 square kilometres on a general East/West axis, ranging between the populous gold mining heartland of Southern Africa and the arid area of the Kalahari desert. The capital Mmabatho is situated in the South-East, in the belt of central Southern Africa (Masibi and Coetzee, 1989:6 and Richards, 1987:10).

Bophuthatswana shares common borders of 2 790 kilometres with South Africa, except the Molopo and Lehurutshe districts which border on Botswana for 260 kilometres. Although the country covers an area of 44 055 square kilometres, the biggest area measured 16 000 square kilometres in the Kuruman and Kanyesa districts as shown in Figure 1.

Physically Bophuthatswana is a flat country with gently sloping areas ranging from 1 000 to 2 000 metres above sea level. Its population is estimated at 1,7 million inhabitants in 1985 (Population Census Report No. 2, 1985:191). The climate follows that of a dry steppe with warm to hot summers and cool winters. The average temperatures range from 22,5 °C in summer to 12,5 °C in winter (Richards, 1987:10). The rainfall occurs in summer from November until early

April and averages from 300 mm in the dry west to 600 mm in the east which is enough for dryland agriculture (Watson, 1987:224).

### 3.3 *SECTORAL CONTRIBUTION OF THE AGRICULTURAL SECTOR TO GDP*

The Bophuthatswana economy is basically rooted in commerce, industry and mining as the most dynamic forces of the country's economy. The platinum group of metals provided the lion's share of the foreign exchange (Richards, 1987:88). This is seen as the economic mainstay of Bophuthatswana, not only from the foreign exchange it generates and employment it creates, but also from the local expenditure it provides. The contribution of the agricultural sector to GDP is lacking behind as compared to the other sectors of the economy (see Table 3).

**TABLE 3: Contribution of agricultural sector to GDP, Bophuthatswana 1991 (R'000).**

Agric.	Mining	Manuf.	Constr.	Trade	Transp.	Rest	Total
230726	3266400	744670	249281	320286	267450	1415795	6494608
3%	60%	8%	3,4%	5%	3,6%	17%	100%

Source: Potchefstroom University, 1992.

Economic growth is a key for economic development, and it is conventionally measured in terms of certain components of the GDP as their rates of increase (Keeton, 1984:276). Agricultural development influences economic growth, embracing the concepts of quality of life and increase in output and productive capacity. In meeting employment opportunities, the Bophuthatswana industrial demand has grown, creating approximately 60 000 jobs. Industrial townships were also expanded by building more factories (Anon, 1990:14).



FIGURE 3: The former Republic of Bophuthatswana.

### 3.4 *AGRICULTURAL SECTOR OF BOPHUTHATSWANA UP TO 1991*

The agricultural sector of the area of study has two main basic components, namely traditional and modern farming.

#### 3.4.1 *Traditional agricultural farming*

Agriculture has been the most important economic activity of many rural areas and occupies a prominent place in the economies of Southern Africa (Low, 1982:37 and Bembridge, 1986:27-29). Over half of the economically active population is estimated to be employed in the South African agricultural sector because of its highly diversified agricultural economy (Fenyés, 1982:10-11; Low, 1982:37 and Bembridge, 1986:32). The same line of thinking is also generalised for Zambia, Zimbabwe, Botswana and other Southern African countries where the share of agriculture in the GDP is estimated to be below 20% (Low, 1982:37).

This section is concerned with the farmers who rely mostly on household labour as the most important factor of production. Capital availability in this peasant farming sector is almost negligible. The average land-holding per peasant farmer in the area of study is estimated at 3 hectares, and the cultivated area per peasant farmer rarely exceeds two hectares (Erskine, 1992(b):38). The peasant farming system is likely to prevail in rural parts of the area studied because there is limited land available. Land also has a high value in almost all rural areas because it is the main factor of production.

The peasant farmers have limited resources to increase their agricultural production and to meet their demands for food. The growth in the demand for food and the types of capital (technology) employed to meet this demand are such that economic, social and environmental costs are high, which threatens their *per capita* welfare (Crosson, 1991:553). The limited amount of capital, labour allocation and the lack of knowledge of resource combinations among farm activities also seem to be the main constraints to increase productivity in the peasant farming sector. The peasant farming agricultural sector produces mostly for farm household consumption and to a limited extent for the domestic market.

#### 3.4.2 *Modern agricultural farming*

The modern agricultural sector of the area of study is mainly capital intensive. The output in this sector depends basically on paid labour, capital equipment and the

technology of production. Because of the use of machinery, processing plants, and other equipment, the share of capital in the modern farming agricultural sector is much higher than in peasant farming. The modern farming agricultural sector tends to increase the agricultural production and utilisation of food significantly. It also provides an effective level of the rural income increase, the methods and ways of use of agricultural resources and generally produces entirely for internal and external markets.

### 3.4.3 *General conditions*

The present state of agriculture in the area of study, even with the contribution of the modern farming sector, still inhibits economic progress and an improvement of rural life because agriculture controls the economic and social life of about 70 percent of the rural people (Cox, 1985:17). Progress towards acceptable rural living standards for the mass of the rural communities is vital. Failure to improve the levels of living in the rural areas tends to increase migration to the cities substantially (Cox, 1985:17).

Although Bophuthatswana was spread over three diverse agronomic zones, it had the potential to become self-sufficient in basic food supply with its production of a variety of agricultural products (Richards, 1987:74). The government had recognised that increased productivity of the agricultural sector was essential for its economic growth and development. This also constitutes to the main viewpoint of the models by this study to achieve economic development (Anon, 1992:12).

The effects of the competitive position of agriculture are that farmers experience continuously decreasing levels of profitability on the one hand and on the other hand their cash flow situation is under pressure. The ability of farmers to meet adverse climatic conditions determines their vulnerability to financial setbacks. Although these are negative effects on the area's agricultural sector, agriculture has always been one of the most important sectors in the country's economic development (Agricor, 1989:1).

According to Mooke (1991:29) the country's economic development can be promoted through developing an agricultural industry. This sector will be able to meet the nutritional requirements of the population by looking at present demands and supplies.

Bosman (1987:18) expresses the opinion that the country's farming community has improved to such an extent that they could improve the quality of life. In 1987 the domestic income of the Bophuthatswana agricultural sector accounted for 10 percent of the GDP (see Table 4).

**TABLE 4: Estimated domestic income of the main sources of activities at market prices, Bophuthatswana, 1985-1987, (R'000).**

Years	Agricultural activities		Industrial activities		Services (All)		Total	
		%		%		%		%
1985	41699	6,6	578600	43,5	586497	49,1	1 206796	100,0
1986	47256	7,5	647571	42,4	728445	50,2	1 423272	100,0
1987	53598	10,2	734445	40,5	975221	49,3	1 763264	100,0

Source: Richards, 1987:59.

As for agricultural activities the farming community is not looking only to outside institutions for assistance, but it is prepared to help itself. To tap the potential investment source within the agricultural sector, the Agricultural Bank has decided to serve the people by offering them a range of services including deposit accounts for which they have long expressed a need (Richards, 1987:57).

The government's concern for its people had been shown through the measures taken to alleviate the country's severe drought conditions. In addition, the drought relief has rendered assistance in different forms from government departments and parastatal bodies (see Table 5).

**TABLE 5: Bophuthatswana drought relief initiated by the government, 1988.**

Departments	Assitance (R)
Agribank	3 909665
Agricor	3 509325
Agriculture	893727
Bop. Defence Force	118218
Health	48454
Public Works & Water Affairs	2 842843
National Parks	12847
Bop. Nat. Provident Fund	10941
Tribal Authorities	31290
<b>Total</b>	<b>11 377310</b>

Source: Richards, 1987:81.

According to Saul (1991:4) the government of Bophuthatswana has been pro-active in the improvement of the economic development through industrial, agricultural, tourism, commerce and small business development. This had been an approach to the basic needs of the population of the area of study, and which Keeton (1984:279) recognises that as long as the people remain deprived of the essentials required for an economically productive life, they would neither contribute to economic development nor benefit from it's growth, but rather remain on the outside of the economic development process. In this way, overall economic development cannot occur unless it reaches all sections of the population, and this process will not be possible if large groups of the people are left apart.

### **3.5 CHARACTERISTICS OF AGRICULTURE IN THE AREA OF STUDY**

The choice among alternative production activities in the area studied was influenced not only by customs and habits, but mainly by the incentives and opportunities to improve the national income and the social environment including the risks associated with these opportunities.

While the farmer hopes that the decision he makes will be to his greater economic and social advantage, the government hopes that the decisions made will be to the advantage of the economic and social development. This section presents some of the characteristics of agriculture in the area studied.

### **3.5.1 *Main objectives***

Experience has shown that the low productivity in agricultural supply would limit economic growth and development of the country. Raising agricultural productivity and inducing a market surplus of the farm products has been a major concern of the government (Agricor, 1990:1). However, one of the most important characteristics is also the creation of a generation of farmers able to help the agricultural sector to adequately supply and feed a growing population, to contribute significantly to overall economic development and to create a better life for all. In the area of study this cannot be achieved over a short period of time, because many young people still associate agriculture with uneducated labourers. In contrast agriculture is a skilled profession and a financially rewarding activity (Gittens, 1991:24). As a matter of fact, attitudes are changing due to action taken by the Agricultural Development Corporation of Bophuthatswana and its commitment to improve the standards of agriculture in the area.

### **3.5.2 *Climate***

The potential supply of agricultural commodities in the area of study is determined by its climate and the type of soil (Watson, 1987:224). About 12 percent of the area studied is regarded as potential arable land. Although droughts have a negative impact on the agricultural sector of the area, there was some development of different economic sectors including agriculture during the past years. Among them have been major changes in output patterns, organisation in the services, and considerable variations in the farm size, employment and income (Agricor, 1990:1-2). Generally the climate is that of a dry steppe with warm to hot summers and cool, though sun drenched winters, with an average rainfall of 300 to 700 mm which is sufficient for dryland agriculture (Richards, 1987:10).

### **3.5.3 *Supply by the agricultural sector***

In most African countries agricultural supply is in a crisis after frequent droughts, high input costs, growing expenditures on food imports and falling export earnings which have been cutting into living standards in these countries (Lele, 1989:45). All these effects have been pervasive on the income of agricultural producers and on the supply of food and raw materials for industry, employment, savings, government revenues and the demand for goods and services produced outside the agricultural sector. Bophuthatswana is no exception.

In thinking about agricultural supply in the area of study, it is useful to distinguish between the economic costs of increasing supply and the environmental costs. Crosson (1991:556) argues that the economic costs of supply reflect the prices and productivity of land, labour, fertiliser, machinery and all the other resources farmers would purchase for use in the production process. These are the costs paid mainly by the farmers, while the environmental costs are damages to natural resources such as water quality and ecological systems, losses of animals and other relevant things which are incurred in the process of agricultural production.

#### **3.5.4 *The demand side***

The principal outputs of the study area's agricultural sector are maize, wheat, sorghum, soyabeans, sunflower, groundnuts, cotton, dry beans, peas and a wide range of fruit and vegetables and livestock products, which are highly in demand by the local consumers. This study investigates maize, wheat and sorghum production in the study area because it is the basic food products consumed on the domestic markets. The demand for cotton, dry beans, groundnuts and peas is of little importance.

#### **3.5.5 *Maize production in the study area, 1978-91***

Agricultural output in the area of study could be made significant by using more effective means of production. Good progress has already been made although maize is produced mainly for domestic consumption, even with the possibility of exports to neighbouring countries (Richards, 1987:7).

The exact figure of maize consumption in the studied area is not available. An estimate of required maize consumption is that it could be 100 kg *per capita per annum*, given the potential (Potgieter, 1987:30). This will result in total consumption by the population (1,7 million) of 170 000 tons of maize for the 1987/88 season. With an estimated production of 98 000 tons of maize, it is clear that production in the area studied is not near the optimal consumption needs for its population (Potgieter, 1987:31). However, the South African know-how should be expanded to the area of study in order to remain competitive in maize production in particular and in grain production in general. Priority should be given towards development and expansion of the internal market for consumption and economic viability in the area being studied (Bosman, 1987:21).

the production of maize benefits from incentives and shows how farmers could become more competitive if they receive similar treatment.

**TABLE 6: R.S.A. government contributions towards the maize industry, 1978/79 - 1985/86.**

Years	Contributions (R. Million)
1978/79	49,7
1979/80	45,4
1980/81	72,2
1981/82	50,0
1982/83	85,0
1983/84	118,7
1984/85	172,5
1985/86	106,6

Source: Bophuthatswana Agricultural Marketing Board, 1987:42.

Table 7 provides the basic statistics of maize (area and production) of commercial agriculture by province in South Africa, 1980/81 - 1991/92. This information gives an idea of the relative importance of maize production in the area in which the two districts are situated. In the province the area cultivated and quantity of production are very significant, namely the North West Province, although the average yield is below the average for all the areas. It gives a clear indication of how important maize production is, but at the same time of the need to increase productivity in the study area.

The study area's involvement in maize production should certainly be encouraged in assisting maize production in that area, at least to the same level as in South Africa farmers, and even to a further extent to help in the anticipated structural changes in agricultural development. In this way the former Bophuthatswana could become an important exporter of maize and share in the benefits of an exporting country like South Africa where maize production is relatively important. The studied area's involvement in maize production should certainly be encouraged in assisting maize production in that area, at least to the same level as the South African farmers, and even to a further extent to help in the anticipated structural changes in agricultural development. In this way the former Bophuthatswana could become an important exporter of maize and share in the benefits of an exporting country, like South Africa where maize production is relatively important.

**TABLE 7: Maize: Area and production of commercial agriculture by province, 1980/81 - 1991/92.**

Production year	Western Cape	Northern Cape	Eastern Free State	Northern Free State	Southern Free State	Total OFS	Eastern Cape	Natal	Eastern Transvaal	Northern Transvaal	PWV	North West	Total
<b>Area planted (1000 ha)</b>													
1980/81	4	314	372	872	220	1 464	38	143	612	145	299	1 250	4 269
1981/82	4	295	344	874	195	1 413	36	148	620	134	299	1 249	4 198
1982/83	4	277	335	839	178	1 352	35	144	611	126	299	1 230	4 078
1983/84	4	246	334	838	193	1 365	35	141	599	126	297	1 214	4 027
1984/85	4	220	339	792	159	1 290		143	624	115	292	1 191	3 913
1985/86	4	232	359	847	199	1 405	36	142	628	115	285	1 108	4 055
1986/87	4	226	342	836	182	1 360	35	145	636	112	291	1 222	4 031
1987/88	3	200	313	747	129	1 189	33	146	594	93	273	1 125	3 656
1988/89	3	209	334	760	152	1 246	33	133	633	71	272	1 178	3 778
1989/90	3	151	303	696	129	1 128	30	122	619	54	240	1 129	3 476
1990/91	2	143	250	516	111	877	26	103	580	47	216	1 031	3 025
1991/92	3	130	308	674	147	1 129	29	110	640	50	249	1 112	3 452
<b>Production (1 000t)</b>													
1980/81	6	966	1 111	2 899	477	4 496	54	593	2 451	394	1 112	4 350	14 422
1981/82	5	520	494	1 802	333	2 629	50	282	1 228	175	818	2 555	8 262
1982/83	4	325	313	897	126	1 336	34	149	635	67	302	1 151	4 003
1983/84	4	106	505	719	99	1 323	31	391	1 462	113	473	406	4 309
1984/85	5	348	794	1 852	293	2 939	47	457	1 302	239	753	1 882	7 972
1985/86	5	280	875	1 610	374	2 859	49	528	1 924	220	680	1 415	7 960
1986/87	5	294	613	1 319	215	2 147	45	393	1 797	166	753	1 488	7 088
1987/88	4	340	663	1 299	172	2 134	37	385	1 413	136	687	1 617	6 753
1988/89	4	616	950	2 342	337	3 629	41	438	2 232	153	833	3 539	11 586
1989/90	3	277	654	1 809	221	2 684	35	342	1 917	99	673	2 354	8 384
1990/91	3	260	543	1 342	186	2 071	33	384	2 111	106	743	2 116	7 827
1991/92	1	184	222	557	85	864	12	186	920	14	340	370	2 891
<b>Average yield (t/ha)</b>													
1980/81	1,50	3,08	2,99	3,32	2,17	3,07	1,42	4,15	4,00	2,72	3,72	3,48	3,38
1981/82	1,25	1,76	1,44	2,06	1,71	1,86	1,39	1,91	1,98	1,31	2,74	2,05	1,97
1982/83	1,00	1,17	0,93	1,07	0,71	0,99	0,87	1,03	1,04	0,53	1,01	0,94	0,98
1983/84	1,00	0,43	1,51	0,86	0,51	0,97	0,89	2,77	2,44	0,90	1,59	0,33	1,07
1984/85	1,25	1,58	2,34	2,34	1,84	2,28	1,38	3,20	2,09	2,08	2,58	1,68	2,04
1985/86	1,25	1,21	2,44	1,90	1,88	2,03	1,36	3,72	3,06	1,91	2,39	1,17	1,96
1986/87	1,25	1,30	1,79	1,58	1,18	1,58	1,29	2,71	2,83	1,48	2,59	1,22	1,76
1987/88	1,33	1,70	2,12	1,74	1,33	1,79	1,12	2,64	2,38	1,46	2,52	1,44	1,85
1988/89	1,33	2,95	2,84	3,08	2,22	2,91	1,24	3,30	3,53	2,15	3,43	3,00	3,07
1989/90	1,00	1,83	2,16	2,60	1,71	2,38	1,17	2,80	3,10	1,83	2,80	2,09	2,41
1990/91	1,50	1,82	2,17	2,60	1,68	2,36	1,27	3,73	3,64	2,26	3,44	2,05	2,59
1991/92	0,33	1,42	0,72	0,83	0,58	0,77	0,41	1,69	1,44	0,28	1,37	0,33	0,84
Average	1,16	1,73	2,07	2,08	1,55	2,01	1,16	2,97	2,76	1,68	2,64	1,61	2,06
Growth rate (%)	-12,8	-6,8	-12,1	-11,8	-11,3	-11,9	-10,6	-7,8	-8,9	-18,7	-8,7	-19,2	-11,9

CV : Coefficient of variation

Source: Directorate Agricultural Economic Trends 1992 (as adapted) - DBSA

Although insufficient data exist about the economic viability of maize production in the study area, some estimations about production are available (Potgieter, 1987:50).

The average yield of maize is between 1-2 tons per hectare. The net producer prices in 1987/88 season were as follows: white maize R216,00 per ton and yellow maize R204,00 per ton for the best grade. The total production input costs for the Western region for instance, varied between R243,00 to R306,00 per hectare, plus the marketing costs at an estimated cost of R50,00 per hectare (Potgieter, 1987:50).

The average production potential of maize in Southern Africa has been 45 percent lower than in South Africa. In 1970 for example, the average production of maize in the area of study has been 300 kg per hectare, as compared to an average of 1,4 ton per hectare of the South African farmers in 1970/71. The farmers have the opportunities for vertical expansion of maize production (Agrocon, 1982:5).

Although limited progress has been made, much can still be done to increase maize supply in the area.

The area of study is potentially able to promote maize production in average yield rates of 2 to 3 tons per hectare and to expand the area planted by almost 25 percent (Agrocon, 1982:5). Maize production in the area should not be seen in isolation from other productions of grain because it's consumption is very closely related to the production of the other two biggest crops, namely wheat and sorghum. However, since so many variables are involved in the production process of maize, an optimal utilisation of the resources for self-sufficiency cannot be expected overnight.

### **3.5.6 *Wheat production in the study area, 1978-91***

From an economic viewpoint wheat production could reduce the quantity of imports for local consumption. From a strategic viewpoint, it is undesirable for any country to depend solely on another country for a staple food such as wheat because of the dynamic nature of political systems and international relations.

In the area of study, wheat production is undertaken at the Taung and Tsholofelo irrigation schemes and also at the Bethanie and Thaba Nchu dryland projects. During 1985/86 a total of 3 364 hectares were cultivated, yielding almost 6 539 tons with a gross value of R1 990 352,00. This production was in addition to stocks of 5 334 tons on hand, giving a total of 11 873 tons to the country. In the same year

42 226 tons were used in the manufacturing of bread and confectionery in the area of study, which indicates the discrepancy between production and consumption (Tube, 1987:58-59).

From the technical aspects of wheat production, many districts of the area of study fall within the known wheat producing areas of Southern Africa. Thus, in these areas there is at least the potential to do as well within its borders as the areas on which it presently depends. If production could be increased accordingly, the area of study could meet its own demand for wheat and wheat products.

Since the directly allocatable costs of maize and wheat are similar, the producer prices and the yield per hectare of the two crops should be almost the same (Tube, 1987:58). Although the price of wheat is much higher than that of maize, the low yield per hectare obtained in wheat production means that the maize producers still get a higher gross margin per hectare (Tube, 1987:60), because the present yield on wheat productions is poor, about 0,86 ton per hectare on average. In the USA, Australia, Canada and Western Europe for instance, wheat yields are three times higher and the cost per ton is much lower than can generally be achieved in Southern Africa (see Table 8).

Accordingly, given the present yield levels, the price of wheat will have to increase substantially for its gross income per hectare to match that of maize. A rotation planting system on the same piece of land would be required to give the best of both crops to be produced (Tube, 1987:60). This would reduce the risk by being diverse.

Wheat consumption in South Africa is growing by about 100 000 tons *per annum*, and by the end of the century 3,5 million tons will probably be consumed annually as compared to 2,16 million tons in 1986. This could be grown locally, but the cost would be prohibitive, unless yields could be drastically increased.

Given the low level of wheat production, the former Bophuthatswana cannot hope to satisfy all its requirements for wheat and wheat products.<sup>16</sup> An important aim would be to strive to reduce import dependency through both area expansion, yield improvements and crop extension.

### 3.5.7 Sorghum production in the area of study, 1978-91

Grain sorghum is one of the most important traditional products in the Southern Africa region. It is being produced by project farmers, cooperatives, subsistence farmers as well as private commercial farmers. The supply to final consumers is through wholesalers, supermarkets and other retail dealers.

**TABLE 8: World production and stock position for coarse grain and wheat for the 1976/77 to 1985/86 marketing seasons.**

Marketing season	Area harvested '000 000 ha	Yield (t/ha)	Closing stocks million ton	Production million ton	World trade million ton	Total utilization million ton
<b>1) Coarse grain</b>						
1976/77	344,7	2,04	83,4	704,8	83,9	688,1
1977/78	346,4	2,03	94,1	701,6	88,8	690,9
1978/79	343,8	2,20	102,1	755,1	92,7	746,9
1979/80	343,2	2,17	102,6	743,9	99,2	743,3
1980/81	342,4	2,14	90,6	732,9	108,0	745,1
1981/82	350,2	2,20	120,9	769,8	96,6	739,6
1982/83	339,2	2,30	148,5	779,1	89,9	751,4
1983/84	334,2	2,05	72,5	685,5	91,9	761,6
1984/85	339,2	2,38	101,5	808,5	101,9	779,5
2) 1985/86	342,9	2,46	171,1	842,5	84,9	772,8
<b>Wheat and coarse grain</b>						
1976/77	577,9	1,95	183,3	1 126,2	147,1	1 071,9
1977/78	573,5	1,89	178,3	1 085,8	161,6	1 090,3
1978/79	572,7	2,10	203,0	1 202,0	164,7	1 177,1
1979/80	571,5	2,04	183,7	1 168,4	185,2	1 187,7
1980/81	579,4	2,03	168,8	1 175,9	202,1	980,0
1981/82	588,8	2,07	205,9	1 218,2	197,9	1 181,1
1982/83	576,7	2,18	244,8	1 285,2	188,6	1 219,3
1983/84	563,4	2,09	173,4	1 176,5	193,8	1 248,0
1984/85	570,4	2,32	217,9	1 324,1	208,0	1 279,7
2) 1985/86	572,2	2,35	295,4	1 334,6	170,9	1 267,1

Source: Maize Board, Report on maize 1986, p. 24.

1) Maize, barley, oats, rye, sorghum, millet and mixed grains.

2) Estimates.

Generally, sorghum production in the former Bophuthatswana is very small. For example, during the 1985/86 season, production had been estimated at 1 846 tons

(see Table 8). A study by the Bophuthatswana Marketing Board has revealed that grain sorghum is produced by the private commercial farmers in the area (Mekgwe, 1987:92). For all practical purposes Agricor projects and various co-operatives financed by Agribank have been producing nearly all the grain sorghum in the area of study since 1980.

**TABLE 9: Estimated grain sorghum production in the area of study, 1985/86.**

Places	Districts	Production (tons)
Tsholofelo	Lehurutshe	75
Setlagole	Ditsobotla	135
Mooifontein	Ditsobotla	870
Thaba Nchu	Thaba Nchu	510
Bethanie	Odi	40
	Total	1 630

Source: Mekgwe, 1987:91.

Agricor has undertaken to increase sorghum production as one of their projects and, should conditions be favourable, it could be expected to produce more than 10 360 tons *per annum* in the area of study. In that way, sorghum would become a more favoured crop in the area due to its drought resistance (Mekgwe, 1987:92).

To determine the quantity of grain sorghum imported into the studied area or exported to other countries is difficult because of the non-existence of recognised borders. Assuming that the estimated production of 1 630 tons for 1985/86 in the area of study was all distributed locally into human consumption, then it would be reasonable to express that, of the 8 196 tons of grain sorghum consumed locally in 1985/86 season, 80 percent originated from the R.S.A..

Grain sorghum production in the R.S.A. is very erratic with regards to both the area, grain production and the average annual yield per hectare. Climate conditions are, however, the main factors contributing to these wide variations found in the yearly production (Mekgwe, 1987:98).

As in the case of maize and wheat, sorghum is also under the South African Marketing Board's control. All the prices of grain production in the area of study are the same as in the R.S.A. due to the agreement between the two Marketing Boards. Bophuthatswana as an independent State should have considered the

objectives of self-sufficiency. Therefore, it should cautiously increase its production to the levels of local consumption in order to be independent from the R.S.A. in grain sorghum supply. On the other hand, in increasing its domestic grain sorghum production caution should also be taken by examining the R.S.A. sorghum production because of its influence on the area being studied in terms of exports.

### 3.5.8 *Growth of farm output*

This section describes growth of farm output for economic growth of the area of study. The discussion follows an analysis of crop production as given in previous sections of this chapter.<sup>17</sup>

Agricultural output growth has been different from the viewpoint of individual crop performance. Maize performance has been good as compared to wheat and sorghum outputs. Despite the poor performance of the small farmers in wheat and sorghum supply, the total volume of food produced in the area is additional evidence of a good performance of the agricultural sector in contributing to economic growth.

## 3.6 *CONCLUSION*

The agricultural production in the area being studied is rather diversified due to variations in climatic conditions and farmer's behaviour. The most important outputs are maize, wheat, sorghum and livestock; although sunflower, groundnuts, soybeans and a wide variety of fruit and vegetables have also been produced (Potgieter, 1987:30-52; Tube, 1987:55-61; Mekingwe, 1987:90). Generally the agricultural production is not enough to satisfy the domestic demand for food in the area of study. Consequently, the existing domestic demand for food in the area is supplemented by significant quantities of agricultural products from the R.S.A.

The problem of low and slow yield increases for agricultural production in the area is discussed.<sup>18</sup> In most cases yield per hectare is one of many indexes of agricultural development and growth that influences changes to the living standards of people. For a developing country to escape from food dependency, an overall agricultural growth of at least 6 percent *per annum* is needed. Though agricultural

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17 Discussed in sections 3.5.5; 3.5.6 and 3.5.7.

18 See for example Tube, 1987:58.

production in developing countries has the potential for growth, it can be greatly affected by weather, disease incidences and other environmental conditions (Hulse, 1991:546). Both physical and economic constraints on agricultural production can be influenced by providing careful adjustment in the direction and pace of agricultural development. There exists a diversity of instruments that can be used for leading and pulling the agricultural sector towards a desirable change (Cox, 1985:17-18). However, agricultural research and viability studies are needed.

The primary aim of this chapter was to examine the position of the agricultural sector in the economic development process and the mutual relationships between the various main branches of agriculture in the area of study. The second aim was to make positive contributions to the agricultural economy and the economy of the area being studied in general.

The performance of maize has been good for both small and large scale farmers. An increase of 10 percent in the use of fertiliser by small farmers would increase outputs of wheat and sorghum which would affect growth in the economy. Although there is a poor performance in wheat and sorghum production by the small farmers, the total volume of food supply has been an additional evidence of a good performance of the agricultural sector in contributing to economic growth (see appendix B3).

## **CHAPTER FOUR**

### **AGRICULTURAL DEVELOPMENT POLICY IN BOPHUTHATSWANA UP TO 1991**

#### **4.1 INTRODUCTION**

The agricultural sector directly controls the economic and social life of about 70 percent of the population in the area of study (Fenyés, 1982:10). The present state of agricultural production in the area, although improving slowly, still inhibits economic progress of the rural areas, frustrating the improvement of their lives and encourages urban migration. Accelerated levels of economic development, political stability and human well-being depend strongly upon how soon the area can materially enhance political responses to the development of the agricultural and rural sector. Food production has been an essential task for every country to embark upon. It is therefore important that agricultural planning and development should have precedence in the planning of the area being studied (Mekgwe, 1987:90).

The primary aim of this chapter is to describe the agricultural development policy in the area of study and how it could contribute to the development of the agricultural sector in the country. The second aim is to supply the relevant information to policy-makers, planners and development agencies in the area of study to substantially increase the efficient use of agricultural resources to obtain higher rural income levels.

The chapter discusses a historical background on agricultural development policy, focuses its attention on the role of development policy in general, agricultural development policy in the area of study with the emphasis on crop and livestock production, land tenure policy in the area followed by policy implications and a conclusion.

#### **4.2 HISTORICAL BACKGROUND**

Economic development could be seen in the process of actual changes that have taken place in many developing countries. The scope and pace of the local government's economic development activities have increased greatly in recent years

(Clingermayer, 1990:539). Urban and rural people have begun to question why economic development is promoted in the cities rather than in the rural areas.

Historically the policy-maker's role is to foster the selection of choices in such a way that when the farmer makes the decision that is best for him, it is also likely to be best for economic development of the country (Cox, 1985:18). Government response to the needs of the rural areas should be the provision of price incentives, infrastructure, agricultural research, credit availability, marketing and adequate areas of potential productive lands. The lack of sufficient food supply has been a constraint to the nutritional levels of the rural population. The investment with this agricultural sector could contribute substantially to increase food supply and growth and development. This would bring hope for subsistence farmers who are victimised by the present inequalities (Cox, 1985:17).

A thorough understanding of the components of an agricultural sector is vital to set up realistic goals, formulate an acceptable strategy and develop and implement sound agricultural development plans. Strategy formulation and planning ought to be based on thorough analysis of this sector which the agricultural development policy tools hope to influence (Cox, 1985:18). Policy instruments should re-enforce the position and role of the agricultural sector in the process of economic development. This need is analysed in section 4.3 in general.

#### **4.3 THE NEED FOR AN AGRICULTURAL DEVELOPMENT POLICY FRAMEWORK**

Generally, several reasons for the use of a development policy could be given:

1. Clingermayer (1990:539) for example, advocates that development policy may generally be based on economic needs, economic growth, institutional arrangements and interest group actions.
2. Danckwortt (1989:21) expresses that development policy has only a supportive role in the development process of a country. It's main priority has been the creation of an improved global economic framework and the prevention of cultural alienation.
3. The number of people living under the poverty line, with too low incomes to obtain a minimum of food and to satisfy other basic needs, is enormous. A breakthrough is necessary to reduce mass poverty. This can only be

achieved through a policy on political, economic and socio-cultural parameters for a self-help establishment (Repnik, 1991:4).

4. Schoop (1989:5) illustrates how difficult it can be at times to translate justified needs into practical solutions without straying into the dangerous political arena.
5. Development policy should provide support and ensure that development is sustainable over a long term for the present and the future generations (Danckwortt, 1989:21).
6. The context in which agricultural development policy is formulated and implemented differs from one country to another. The difference may be with respect to the demand outlook confronting the agricultural sector of a country for example, or to the product-pattern characterising it, or the resource potential available to it (Krishna, 1979:497). The main role of agricultural development policy should be to foster sustainability through provision of cheap basic foods to the population, to contribute to foreign exchange earnings through exports of agricultural commodities, to help increase rural incomes, to create job opportunities, to reduce food imports, to supply raw materials to industry and to support and sustain economic growth and development. Briefly it is to create changes in the agricultural production, distribution and utilisation of the outputs (Tshibaka, 1986:16; Arnon, 1987:4; Swarn and Rawat, 1990:123; Evans and Ngau, 1991:520 and Van Zyl, 1991:27).
7. Agricultural development policy should also be centred on the creation of job opportunities and amelioration of poverty in the intermediate period. Labour should be productive given the scarcity of available resources (Van Zyl, 1991:27). Policy-makers should review certain policy aspects impairing the creation of job opportunities in agriculture and which have resulted in the distorted prices of the production factors relative to their scarcity.
8. Katz (1989:19) advocates that the government should be prepared to invest substantial resources in agricultural activities needed for agricultural policy since returns appear to be enormous in these activities. Agriculture remains the most important economic activity in improving nutritional levels and contributing to economic development.

9. A good economic and agricultural development policy should balance the different objectives to maximise agricultural growth over a longer period of time (Katz, 1989:19).
10. Finally, agricultural development policy and programmes should provide a framework through which both male and female farmers are meant to gain access to information and inputs for potential and higher agricultural productivity to stimulate the economic development process (Katz, 1989:19).

Given these general reasons for a development policy, the attention is now focused on the area of study.

#### **4.4 AGRICULTURAL DEVELOPMENT POLICY IN THE AREA OF STUDY**

Agricultural development policy in the study area has been mainly aimed at improving the agricultural sector as a whole, the eradication of rural poverty, the creation of living conditions acceptable to all rural communities, and enabling people to practice agricultural activities as a solution to economic growth and development (Agricor, 1991:1, 8). This can be achieved through provision of aid and by conducting different development programmes based on a quality criterion rather than quantity. The Bophuthatswana agricultural development policy took a pragmatic approach with tried methods of agricultural development although new challenges and perspectives were constantly considered for further improvements.

The Agricultural Development Corporation of Bophuthatswana's fundamental policy statement was to "attract and retain an optimal number of committed and competent employees, by developing their full potential, providing a participative, fair and stimulating working environment and appropriately supporting their constructive community involvement in agriculture, thereby ensuring their effective and efficient utilisation of available resources: (Agricor, 1991:4).

Agricor has developed and approved a range of agricultural development policy instruments to match agricultural development in the area in 1991. These policy instruments include a customer support policy aimed at providing support through advice, services and products related to the customers' needs and constraints, and to enable them to take responsibility for their own destiny and ownership of their agricultural undertakings (Agricor, 1991:5). An agricultural support policy provides customised support to agricultural resources. This would develop

customers' skills for resource utilisation progressively which will optimise agricultural productivity.

However, a macro-economic policy exists which contributes towards appropriate optimal regional linkages, thereby providing a cost effective support infrastructure to enable participants in agriculture and related agricultural activities to realise their full potential of crop production. The specific policy on crop production is discussed in the next section 4.5.

## **4.5 CROP PRODUCTION POLICY**

### **4.5.1 Objectives**

The primary objective of a crop production policy is to ensure that everyone involved directly or indirectly in crop production is continuously encouraged, supported and trained to optimise the utilisation of the natural resources to generate maximum economic and social gains for the farmers in particular and for the country as a whole (Agricor, 1990:1).

The second objective of a crop production policy is to encourage the optimum utilisation of soils, to contribute towards the preservation and conservation of soils as well as to ensure that good quality extension services are available, free of charge, to all farmers in the country. This policy is based on some specific principles as discussed in the next paragraph.

### **4.5.2 Different crop production policy principles**

Three main principles formed the basis of crop production in Bophuthatswana which should be adhered to by all people involved in crop production (Agricor, 1990:1), namely:

1. All arable land should be utilised in accordance with their long-term production potential.
2. Production systems with the highest probability of financial success against the lowest risk should be followed.
3. The active involvement of the farmers with regard to it's farming enterprise will always receive the highest preference and will be continuously

encouraged. The policy could only be implemented if certain services are supplied.

#### 4.5.3 *Services rendered as part of agricultural policy*

The implementation of an agricultural development policy by means of crop production depends on the services rendered to the communities. Such services are the following:

1. ***Finance:*** to facilitate the provision of production credit to farmers complying with minimum standards.
2. ***Marketing:*** to promote and facilitate the marketing of agricultural products providing professional advice to stimulate rationalisation and stabilise the agricultural sector of the economy.
3. ***Management and human development:*** to use crop production as the vehicle to enhance self development of the farmer's activities in particular and the country as a whole.

On the other hand the services depend on the total commitment of the farmers and it is of equal importance to both government and the farmers. This indicates that the farmers should be encouraged continuously and be part of the agricultural policy. An important aspect of the agricultural policy is to determine an appropriate agricultural price. Otherwise the effectiveness of the services rendered may decline and can even disappear (Agricor, 1990:1).

In order to maximise the effectiveness of these services, it must be closely coordinated and assisted by the agricultural support services, e.g. the following:

1. The Agricultural Development Corporation;
2. The Agricultural Marketing Board;
3. The Agricultural Bank, and
4. The Agricultural Co-operatives.

## 4.6 *AGRICULTURAL PRICE POLICY*

### 4.6.1 *Objectives*

Historically the main objectives of agricultural price policy in each and every country have been price stabilisation on the one hand, and on the other hand income stabilisation (Krishna, 1979:498). A reasonable degree of stability of price and of agricultural markets has been the first objective of price support policies (Van Zyl, 1989:343). It's primary feature is to contribute to the long-term assurance of producers in regard to support of their income (Krishna, 1979:498). As an integral part of the development policy, agricultural price policy has generally been used negatively to keep some raw materials cheap for the growing industrial sector and to maximise and transfer the profits of agricultural products to the non-agricultural sectors for investment.

The agricultural price policy in the area studied is complementary to the South African agricultural price policy. In other words, the alternative agricultural budgets for agricultural commodities in the area is influenced by the South African agricultural commodity price. This was due to the agreement between the Bophuthatswana and the South African Marketing Board Agencies, since many agricultural commodities are marketed through these channels (Potgieter, 1987:48).

### 4.6.2 *Reformed agricultural price policy*

Agricultural price policy reforms, such as setting of prices on export crops, credit availability and incentives to farmers, should be reviewed either by eliminating fixed pricing, or by permitting private traders to market some or all of their crops. The government should, if possible announce fixed prices for crops by holding a legal monopoly on principal crops on the one hand, and on the other hand it could liberalise the marketing and pricing of some other food crops. Potential changes in these reforms could affect almost 45-50 percent of the rural communities in the area of study (Humphreys and Jaeger, 1989:7). Overall, the incentives paid to farmers (in real prices for output) will have to increase as the results of liberalisation increases.

Katz (1989:18) supports the idea behind the agricultural price policy reform as featured in many adjustment programmes of different countries and supported by the International Development Association (IDA). These programmes increasingly seek to improve the responsiveness of domestic prices to changing economic conditions

as well as to bring them more closely in line with the required levels. As incentives, agricultural price reforms increasingly affected the production of cocoa in Ghana by more than 40 percent (Katz, 1989:18).

Heavy social costs have been borne by countries that have postponed and avoided such adjustments. While there are social costs associated with these development programmes, there are also social benefits. One example is that the shift in relative prices that are supported by adjustment programmes almost always serve to boost the production and employment in rural areas, where most of the poor people live because they serve as incentives to farmers.

According to Gupta *et al.* (1989:38) the indirect effect of the agricultural price policy stem from the absorption of more factors of production including the agricultural sector itself. Production, exports and stockbuilding would rise while imports would fall with an efficient agricultural price policy. Ineffective price policies will have counter effects on the agricultural sector. It may create increases in the price of factors of production as a result of higher demand from this sector, which might also increase the cost of output from other sectors of the economy.

In the dynamic economics of the agricultural sector, farmers in the area of study have to adjust their production plans and crops often in order to match the changing commodity prices and input costs (Faminov and Laubscher, 1990:259). The degree of self-sufficiency in this area as food production would be determined to a large extent by the agricultural price levels that would be adopted. The disregard of the upper price limits would be an overloading of the government's budget (Weber, 1988:454).

Agricultural price regimes and agricultural price policy reforms in each country like some African, Asian and European countries are complete. However, a useful agricultural price policy could be a production incentive to farmers as a guarantee for stable and growing income from agricultural practices (Weber, 1988:454).

The agricultural price ratios between factor and product prices would determine the required mix of agricultural commodities (Weber, 1988:453). Therefore, a stable agricultural price policy would reduce risks and encourage investment in agriculture. At the same time the possible effects of rising agricultural food prices for consumers and the implications of this agricultural price policy on the government's budget have to be taken into consideration.

## 4.7 VOCATIONAL TRAINING

### 4.7.1 Objective

In a country's development policy, vocational training plays an important role, since the economic development of a country is difficult to achieve without a considerable number of people with different practical skills to promote economic and social development for both the people and the country in general (Fröhlingsdorf, 1989:25).

In the study area the Agricultural Development Corporation of Bophuthatswana (Agricor) has opted for training to build and equip its staff in agriculture and agricultural related matters. Agricor has increasingly stressed training just like other development agencies in the world.

### 4.7.2 Management of training

The fundamentals of development policy behind technical and scientific knowledge, skills are very important for the development of the area under study. The Agricultural Development Corporation of Bophuthatswana has training programmes exclusively for all executive managers, managers, field staff and trainers who, in addition to specialised training, also need to learn different functions of management like leadership and administration. Agricor also assisted with special management seminars to accompany each programme of training. These seminars impart a basic knowledge of *inter alia* leadership techniques, personnel and financial planning, reporting and information systems, which are closely geared to actual practices in the given occupational field of work (see Table 10).

Most of the training courses given to managers and some field staff were taken to the lower level staff by their respective line-managers for field work in their respective functions on development.

According to Danckwartt (1989:22) the fundamentals of the development process are solidarity, responsibility, motivation, mobilisation, participation, and self-help as the main issues that needs to be overcome for the development of the region. Generally speaking, vocational training is important for all development staff because it backs up every trainee to become skilled and to pass on his knowledge to many more people involved in field practices.

**TABLE 10: Some of the training courses offered by Agricor Training Department: February-November 1991.**

Course	No. of people	Variation (%)	Accumulative
Training and Information	145	9,36	9,36
Organising development	112	7,23	16,59
Horticultural Workshops	192	12,40	28,99
Planning	210	13,56	42,55
Time management	6	0,39	42,94
Process management	96	6,20	49,14
Business basic	12	0,77	49,91
Setswana basic	30	1,94	51,85
Day to day performance	48	3,10	54,95
Customer care	136	8,78	63,73
Performance management	84	5,42	69,15
Newsmaster	42	2,71	71,86
Secretarial	42	2,71	74,57
Target management	36	2,33	76,90
Creativity seminars	184	11,88	88,78
Accounting	12	0,77	89,55
Writing skills	12	0,77	90,32
Management support	24	1,55	91,87
Literacy Workshops	126	8,13	100,00
Total	1 549	100,00	

Source: Agricor, 1991.

#### 4.7.3 Literacy programme

Literacy in the economic development process is first and foremost a process of learning, social reform and change in personal attitudes and behaviour. Literacy presupposes a minimum of socio-economic development, it can enhance the development process and eventually make it self-sustaining (Mueller, 1990:18). Literacy is not the start of the development process, but rather an integral component. Financial and technical assistance to development rely on personnel for impact, having laid the necessary foundation in the form of new knowledge, new

attitudes and new patterns of behaviour. It is only when a country possesses the necessary skilled people and recognises the social, political and cultural consequences of its planning, that development will have hope to succeed.

The year 1990 was proclaimed an international literacy year, to underscore that literacy is an integral component of primary education, recognised and legally enforceable as a basic human right (Mueller, 1990:18-19). However, the year 1990 has not been much reason for celebrating. It was a reason for involvement of the government to intensify public awareness of the problem of illiteracy, expand popular participation and launch a plan of action for the eradication of illiteracy (Mueller, 1990:17). The number of illiterates is not known in the area of study. But it appears that almost 36 to 42 percent of the total population in the area are illiterate (Roth, 1990:7).

There are more than 228 adult literacy centers in the area under study funded by the Department of Education, excluding those in charge of Agricor, mainly concerned with helping adults to obtain schooling from the primary school (Roth, 1990:9). The primary school teachers have been regarded as the personnel to use in literacy instruction. Agricor had realised the necessity of undertaking a literacy programme in all the rural areas in the area after it had found that almost 47 percent of farmers taking part in the agricultural programmes were illiterates.

Literacy courses have become an important part of Agricor's development programmes, handled mainly by the community development staff as the most important facilitators of literacy for the community members. It has been noticeable that Agricor is in an ideal position to provide relevant literacy courses to its farmers on agricultural matters, something which has functional relevance for them and which could lead them to a more effective result if properly implemented (Roth, 1990:25). The Agricor literacy policy is aimed at improving the reading and writing skills of both farmers and the total communities of the area being studied for successful participation in the development process.

#### **4.8 LAND TENURE POLICY**

There are severe limitations on agricultural activities without a good land tenure policy. Tapson (1990:573) quoting Cross (1986) and Bembridge (1987) advocates that the freehold system has failed to deliver the benefits expected of it to the majority of the people. Freehold provides the owner with a considerable degree of security of tenure in that he does not have to occupy or use his land in order to retain it.

Reform of a land tenure policy with an appropriate legislative and judicial support system needs to be introduced into an agricultural development strategy (Fenyves, 1988:577).

The Bophuthatswana government had emphasised the need to investigate the communal, tribal and state land tenure systems of production (Directorate of Land Administr., 1991:3-7). The land tenure system proclaimed in the area could become part of the solution of an integrated agricultural development process rather than being a constraint of the social and economic development of the people.

An undisclosed number of farms previously under state control was leased to prospective farmers in the area under study, who were requested to make proper use of these farms and become productive farmers (Mokgadi, 1991:28).

Table 11 presents some policy settings, policy measures and strategies in agricultural development. The table provides four steps for the development of agricultural sector, namely: getting agriculture moving; the agricultural sector as a contributor to economic growth and development; integration of the agricultural sector into the macro-economic policy and the economics of the agricultural sector in industrialisation process.

The most important policy settings for each step are discussed in the central part of the table; and the most important policy measures are provided at the bottom part of the table. This table is a result of combined different viewpoints from different authors regarding the development of the agricultural sector for economic growth.

## **4.9 POLICY IMPLICATIONS**

### **4.9.1 Main arguments**

The main points from this chapter are that by reforming and helping some groups of producers and farmers or industries, others are being influenced due to the interrelationships that exist in the economy and the agricultural sector. Different policy options vis-a-vis the other policies in operation have definite welfare implications amongst people or groups of people. As a result, there is a need for an overall development policy strategy which considers all related producers, farmers, industries, products, and other relevant variables simultaneously. Policy measures have to be evaluated in the context for efficiency purposes. If not, results may be poor or even negative, and they can even be counterproductive at the same time.

Development and distribution of benefits are still necessary and need actions, especially within groups with extreme unequal distribution of income, wealth, power, rights, privileges and other opportunities. It is the unequal distribution of these elements that calls for redistribution of income as a solution to promote the development process (Van Zyl, 1989(b):348). One should consider the relevant interrelationships that exist when designing development policy and the redistributive programmes. Then there may be some probability of reaching the objectives and positive results to be obtained with the application of development policy at the lowest possible social cost. Policy measures emphasising entitlement and affirmative programmes would be considered within the agricultural sector. The combination of some policy measures and strategies appropriate to the agricultural sector in the area of study is presented in Table 11.

#### 4.9.2 *Agricultural development strategy*

Agricultural development strategies provide a way to utilise natural resources by means of crop production which is enhanced by the application of the institutional and operational strategies (Agricor, 1990:2). Regarding an institutional strategy, all the actions of government, agricultural parastatals, local authorities and the farmers should be co-ordinated at both national and regional levels, and their overlapping of responsibilities be eliminated by restructuring the systems if necessary (Agricor, 1990:3).

On the one hand, operational strategy is aimed at sustaining viable agricultural production, which could be enhanced if production related decisions are based on scientific norms and principles. For this reason, the classification of soils in different production categories to their long-term production potential is of vital importance for optimum management. On the other hand, all physical, chemical and other production guidelines and all relevant soil information should be stored for reference to improve the quality and ease of decision-making in the agricultural sector (Agricor, 1990:3).

It is important that alternative strategies to achieve certain policy objectives should be considered. Van Rooyen and Machethe (1991:179) give the following example: By using capital/output ratios for farming, an investment of R1 million in agriculture could be determined to generate more than 1 000 jobs over the short term and almost 500 permanent jobs in the economy.

The agricultural sector would create almost 150 more jobs than in manufacturing, if the capital-output can be improved through promotion of alternative farming systems linkages (Van Rooyen and Machethe, 1991:179-180).

#### **4.10 CONCLUSION**

Agricultural development policy is essentially an instrument that creates changes in the agricultural production process, distribution and utilisation of the output. The correct role of the agricultural sector to stimulate economic growth and development in the wider regional area and the area of study, could be determined by its positive contribution to economic growth and development of the country. Van Rooyen and Machethe (1991:177-178) advocate that this has been an important issue to gain a perspective on the impact of agricultural investment, and it deals with the question of appropriate agricultural development policy tools and strategies to ensure a positive contribution from this sector.

A better understanding of the household economics of the area being studied, is vital to make the necessary adjustments to agricultural policy at both local and state levels. Agriculture has been the greatest resource and the most important economic activity of many rural areas. Therefore it is of vital importance that the agricultural sector be put on a sound footing by creating opportunities for food, cash-crop and livestock production through effective agricultural policy implementation. In designing effective agricultural development policy measures and strategies, it is necessary for the policy-makers to strive towards an optimum combination of complementary policy measures and supplementary programmes and strategies.

To ensure an optimal combination from the agricultural sector, policy measures and strategies should be determined, formulated and implemented accordingly. The instruments will determine the role of the public sector and incentives granted to the agricultural sector. Agricultural development policy formulation in the area should take into account the various conditions prevailing in the rural areas to ensure an effective policy mix to optimise the contribution of the agricultural sector for economic growth and the distribution of benefits. The agricultural development policy as formulated by the Bophuthatswana government could have a fundamental impact on agricultural growth in the area. The major constraint to agricultural policy has always been its implementation. In this practical stage, many essential points are left out and even forgotten.

In order to determine a correct agricultural development policy as an instrument for economic growth and development, the policy-makers should:

1. investigate the process and the state of the agricultural sector as proposed in Table 11;
2. asses the answers in terms of the applicable policy setting;
3. formulate appropriate policy measures, strategies and institutions responsible for the implementation of such policies, and
4. determine financial support and means.

Given the appropriate agricultural policy, the scene should be provided in order to determine the values of variables by the appropriate research methods which would constitute the objectives of chapter 5.

**TABLE 11: Some policy settings, policy measures and strategies in agriculture.**

Agricultural sector From:	Getting agriculture moving (Van Rooyen and Machethe) Mosher	Agriculture as contributor to growth (Van Rooyen and Machethe) Johnston-Mellor	Integrating agriculture into the macro-economics (Van Rooyen and Machethe) Schultz-Ruttan	Agriculture in industrial economics (Van Rooyen and Machethe) Johnson DG.
Policy settings	Institutional change; new appropriate technology; access to markets and incentives; significant investment in rural infrastructure and human capital; local institutional development	Establish market links with industry; technology and incentives to create a dynamic agricultural sector; improve factor markets to mobilise rural resources and incomes.	Declining share of food in urban budgets; push to make agriculture efficient, shift resources out for income distribution programmes for lagging rural areas to improve the quality of life.	Small share of food commodities in consumer budgets; income distribution as a political issue; unemployment in the industrial sector creates pressure to keep labour in agricultural sector.
Policy measures and strategies	Affirmative programmes to support emerging and smallholder farmers, improved political lobbying power; infrastructural development; access to farmer support services; human capital development and training; upgrading of market entitlement; etc.		Restructuring programmes in commercial agriculture; increased price responsiveness; more flexible arrangements to engage production factors-land, labour, capital; improved financial and strategic management; non-farming employment programmes; direct consumer production linkages.	

Source: Adapted from Van Rooyen and Machethe, 1991:179.

## **CHAPTER FIVE**

### **METHODOLOGY OF DOMESTIC RESOURCE COST BENEFIT CALCULATION**

#### **5.1 INTRODUCTION**

This section provides a framework within which a more effective agricultural development policy can be designed for the country. The major emphasis of this section is the formulation of a policy for cash crop production by the small-scale farmers in the area being studied. It is assumed that the institutional framework will remain the same, that is, the government will continue to fix the producer prices for crops and shall have the primary responsibility for marketing. Also, the government will have new policy instruments to encourage and discourage the production of different crops in each district. This approach is designed to answer questions like what main crops should be produced in each district of the area being studied to attain the government's objectives. Once this has been determined, the policymakers could consider the policy instruments leading to the implementation of the desired regional allocation of crops at the district levels.

The regional allocation of crops should be done using a selective methodology which makes possible an assessment of the relative benefits and costs of production of different crops in each district of the area of study. The following section provides a brief consideration of social benefit cost analysis in general, followed by a detailed presentation of the social profitability criteria which could be used within the general framework based upon this methodology. Finally a brief estimation of shadow prices required by social benefit cost analysis is presented followed by the cultural approach at the end of the chapter.

#### **5.2 SOCIAL BENEFIT COST ANALYSIS**

##### **5.2.1 The use of social benefit cost analysis**

The main objective in dealing with private benefit cost analysis has been the maximisation of profits for private firms (Botha, 1991:1). The social benefit cost analysis is useful in the maximisation of the government and public benefits (Steyn, 1991:2; Dodge, 1974:142). When there is more than one government objective, it

is important to weigh the relative desirability of alternative resource allocations according to the extent to which they will assist in meeting the different objectives. The problem of considering both economic growth and equity objectives can often lead to a greater divergence between the social and private benefit cost analysis.

The social and private benefit cost analysis differ in the prices used to evaluate the benefits and costs associated with a particular allocation of resources. In private benefit cost analysis, the market prices are used because they reflect the value of the revenue and cost streams to the firm in maximisation of profits (Dodge, 1976:142). In contrast, the government policymakers use prices which reflect the value of a commodity or factor to meet the government's objectives. These prices are known as "Shadow" or "Accounting Prices", which are a function of the government's objectives as well as the input structure and resource constraints of the economy.

However, the appropriateness of a particular shadow accounting price is determined by the assumptions made with respect to the government objectives and available technology and resources.<sup>19</sup>

Following government policy, shadow prices could be used as a basis for setting domestic prices. The government could even employ a number of alternative policy instruments to ensure that the resulting resource allocation is the same to that which could result from the use of shadow prices (Dodge, 1976:143). Theoretically, shadow prices can be obtained from an economy with a wide ranging planning model, where one can construct and solve the models. Thereby obtaining a description or resource allocation which can maximise the different government benefits. Practically, the construction of such models is not possible for most developing countries because of the absence of appropriate planning models and sufficient data (Dodge, 1976:14).

### 5.2.2 *Criteria for social profitability*

These criteria for social profitability are based on the theoretical framework of dynamic and general equilibrium models (Dodge, 1976:143; Steyn, 1991:2). Some of these criteria are used for intersectoral planning or planning at the project level which is discussed in the following subsection.

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19 See e.g. Sen, 1972:486-501 for discussions.

### 5.2.3 Net social profitability (NSP)

This criterion can be defined as the net gain (or loss) associated with economic activity when all the agricultural outputs, material inputs, and factors of production used in the process of allocation are evaluated at their social opportunity costs, such as through the use of shadow prices (Dodge, 1976:144; Steyn, 1991:2).

The net social profitability is calculated in equation (10).<sup>20</sup>

$$NSP = \sum_{i=1}^n a_{ij}p_i - \sum_{s=1}^m f_{sj}v_s \quad (10)$$

where:  $a_{ij}$  = the quantity of commodity output  $i$  produced by activity  $j$ ;  
 $p_i$  = shadow price of commodity output  $i$  or input  $i$  in domestic currency (R);  
 $f_{sj}$  = quantity of factor of production  $s$  used by activity  $j$ , and  
 $v_s$  = shadow price of the factor of production  $s$ , in domestic currency (R).

Theoretically, the shadow prices used to determine the output and production factors reflect already the government objectives, hence there is no need to adjust the calculation of NSP in order to take such objectives into consideration. Practically, a macro-economic model is needed to estimate shadow prices which can reflect the different objectives of the government which may call for changes to the "Pareto-Optimum" allocation of resources.<sup>21</sup>

Following the viewpoint of Diamond and Mirrlees, when using an appropriate procedure for calculating NSP in a country such as the former Bophuthatswana, one should first obtain NSP estimates based on shadow prices consistent with production efficiency. Thereafter, these NSP estimates which indicate the efficiency solution can be changed if necessary to meet the government policy objectives. The dynamic considerations may call for a change of the resource allocation based on the NSP calculation. This change can be made by estimates of the costs and benefits over time by discounting (Louw, 1991:4), as can be seen in equation (11).

<sup>20</sup> This brief presentation of the net social profitability criterion, is a summary presentation from Scott, 1974.

<sup>21</sup> See e.g. Diamond and Mirrlees, 1972:8-27 for an explanation of the Net Social Profitability.

$$NSP = (u_j - \bar{m}_j - r_j)v_i - \sum_{s=2}^m f_{sj}v_s \quad (11)$$

- where:  $u_j$  = total value in foreign currency of output of activity  $j$ ;  
 $\bar{m}_j$  = total value in foreign currency of imported materials used by activity  $j$  (directly or indirectly);  
 $r_j$  = total value in foreign currency of repatriated earnings of foreign owned factors of production used by activity  $j$ ;  
 $v_i$  = shadow price of foreign exchange, expressed as a ratio of local currency to foreign currency, and  
 $f_{sj}$  = total quantity of domestic factors of production  $s$  employed by activity  $j$ .

The main problem which may exist in applying the NSP criteria is the calculation of the correct shadow price estimates for labour, capital and foreign exchange in the absence of a comprehensive model for economic development. In any case, some normative value judgements will have to be considered (Van Wyk, 1991:3).

Two other additional criteria have been proposed to minimise the errors resulting from the difficulty of obtaining the correct shadow price estimates, namely the social marginal productivity (SMP) and the domestic resource cost (DRC), see e.g. Chenery (1953:76-96).

#### 5.2.4 Social marginal productivity (SMP)

The pioneer work on the social marginal productivity criterion is due to Kahn (1951:38-61), and the proposed modifications on Kahn's work were introduced firstly by Chenery (1953:76-96). The main reason for such modifications was to allow for commodity price distortions to provide for the evaluation of labour, capital and foreign exchange at opportunity cost rather than at the market price.

Following Chenery's proposals (1953:76-96) the SMP can be derived from the NSP as provided in equation (12).

$$V_m = \frac{(u_j - \bar{m}_j - \bar{r}_j)v_1 - \sum_{s=2}^{m-1} \bar{f}_{sj}v_s}{k_j w} \quad (12)$$

where:  $k_j$  = a physical input of capital of the  $m^{\text{th}}$  primary input;  
 $w$  = real production cost of a unit of capital, and  
 $V_m$  = shadow price of capital, or a real accounting rate of interest.

All the variables are explained in (11)

### 5.2.5 Domestic resource cost (DRC)

This criterion measures the efficiency of an economic activity in the transformation of resources into foreign exchange. It is derived from the net social profitability (NSP), and is analogous to the derivation of the social marginal productivity (SMP). The only difference is that NSP as defined in (12), is solved for  $V_1$  (the shadow price of foreign exchange), rather than  $V_m$  (the shadow price of capital). Mathematically, it is expressed in equation (13).

$$\text{DRC} = \frac{\sum_{s=2}^m \bar{f}_{sj} v_s}{u_j - \bar{m}_j - \bar{r}_j} \quad (13)$$

where:  $f_{sj}$  = total quantity of domestic factors employed by activity  $s$ ;  
 $v_s$  = shadow price of the factors of production  $s$  in Rands;  
 $u_j$  = total value of the output of activity  $j$  in foreign currency;  
 $\bar{m}_j$  = total value of imported materials used by activity  $j$  in foreign currency, and  
 $\bar{r}_j$  = total value of repatriated earnings used by activity  $j$  in foreign currency.

The calculation of domestic resource cost is important to determine the comparative advantage of the country (Bruno, 1972:21-22).

A country has a comparative advantage in producing and exporting (or import substitution) agricultural commodities if the total costs of an incremental project (including direct and indirect foreign and domestic costs) are less than the total returns. This can be stated by equation (14).

$$\text{DRC} = (\bar{m}_j + \bar{r}_j)v_j + \sum_{s=2}^m \bar{f}_{sj} v_s < u_j v_1 \quad (14)$$

A direct relationship between DRC and NSP can be obtained by substituting equation (14) into equation (11) to derive equation (15).

$$\text{NSP} = (v_1 - \text{DRC}) (u_j - \bar{m}_j - \bar{r}_j) \quad (15)$$

When  $\text{NSP} = 0$ ,  $\text{DRC} =$  shadow price of foreign exchange ( $v_1$ );

when  $\text{NSP} > 0$ ,  $\text{DRC} < v_1$ , and

when  $\text{NSP} < 0$ ,  $\text{DRC} > v_1$ .

Therefore, an economic activity can be considered socially profitable if its domestic resource cost (DRC) is less than the shadow price of the foreign exchange, this is expressed by  $\text{DRC} < v_1$ . When  $\text{NSP} > 0$ , DRC is considered unprofitable.

By rearranging the terms, the relationship between the domestic resource cost (DRC) and the comparative advantage ( $\text{DRC} \leq v_1$ ) can be expressed as provided in equation (16) (Bruno, 1972:21-22).

$$\frac{\sum_{s=2}^m \bar{f}_{sj} v_1}{u_j - \bar{m}_j - \bar{r}_j} < v_1, \text{ or } \text{DRC} < v_1 \quad (16)$$

It is possible to indicate the relative degree of comparative advantage in producing goods and services within a country by comparing their DRC ratios. However, it is advisable to consider changes in the relative prices if one or more of the activities with DRC's less than  $v_1$  are undertaken (Bruno, 1972:20-22). Therefore, it would be incorrect to conclude generally that if the DRC of one activity is less than the DRC of another, the former DRC is necessarily preferable to the other.

The main purpose of DRC calculations is to provide an indication of which economic activities are socially profitable. This means that DRC's less than  $v_1$  should be encouraged through government policy formulation (Bruno, 1972:20-22). The DRC is a useful criterion to use for *ex-ante* evaluation of resource allocation for crop production in the area of study (Bruno, 1972:20-21). The following reasons explain why:

1. it facilitates the determination of shadow prices of foreign exchange which is difficult to estimate correctly;

2. it places an appropriate emphasis on foreign exchange in assessing the social profitability of alternative crop production allocations in view of the current severe foreign exchange and domestic resource constraints, and
3. for DRC calculations of crop production it is assumed that the crops are mainly for trade and domestic consumption.

### 5.3 POPULATION PRESSURE ON AGRICULTURE

This section discusses the negative effects of the population pressure on agricultural development with emphasis on population growth rates.

The rate of increase in income is always determined by the growth in the factors of production such as labour, capital productivity and technical skills or know-how. In contrast, the rate of increase in population is mainly determined by its natural growth rate. Therefore; if the population grows faster than the rate at which the economy grows, the level of resources available for the country to support its population will determine the growth (Mullins and Myburgh, 1988:71).

Although a model could be developed where resources determine the economic development, a principal limiting factor in the development of the agricultural sector is the population growth. Therefore, this approach is developed and applied for the population as resource.

To avoid population pressure on agriculture, the control of the population growth rate is vital (Fenyas, 1982:49). The projected population growth in the area being studied is about 2,8 percent *per annum* (Department of Economic Affairs, 1985:4). Using the compound interest formula (see equation 17), the *de facto* population for the period until 2000 could be estimated as 2,6 million people (Cissel and Cissel, 1978:84-85). This gives an indication of the expected population density.

$$S = P(1 + i)^t \quad (17)$$

where: S = *de facto* population to be determined in year 2000;  
 P = 1 740 600, estimated *de facto* population in 1985;  
 i = population growth rate (3% is used), and  
 t = time period or year 2000.

There are certain factors which can influence the critical density of the population (CDP). Those that could lower it are:

1. the land tenure system with a more private land system which makes the land scarce in some communities;
2. permanent destruction of the soil as a result of the past agricultural practices;
3. an increase in the area needed per household under modern practices;
4. the change of the farming system from traditional to commercial;
5. higher standards of health which can increase the productivity of the quantity of land cultivated per person, and
6. improved farming skills for the people who return to rural areas and would like to have big holdings.

The factors which can raise the critical density of population include:

1. scientific methods of farming or modern farming practices;
2. indirect population pressure of economic migration of the people to some other economic sectors and cities (see e.g. Erskine, 1990:16);
3. direct reduction of the population pressure by migration to cities, and
4. freeing of lands formerly restricted for agricultural purposes.

The negative impacts of the population pressure require that control should be exercised on both population growth rates and the factors that can lower or raise the critical density of population. The factors that can lower or raise the critical density of population as discussed in this chapter is of relatively explicit importance when discussing the subsistence and commercial agricultural economy of the area of study.

#### **5.4 THE CULTURAL APPROACH**

The cultural approach is cast following the steps set by Contogiannis and Peter (1988:68-70). They have argued that the population as resource and education as culture and behaviour which may occur from development, should be considered as

important for economic growth. For growth to be stimulated, it is important to have at least a population which has some achievement motive.

In the less developed countries, often the large majority of people live in the rural areas. In the area being studied, more than 70% of its population is in the rural areas (Department of Economic Affairs, 1985:5). The problem with underemployment in the agricultural sector in less developed areas including the area of study, is that labour can be recruited and trained for the non-agricultural sectors such as industrial activities, which have little effect on the agricultural sector (Contogiannis and Peter, 1988:69).

Economists have recognised the importance of education and training of the local people as an investment. A society can invest in its people through training to enhance the productive capacity of the individuals and society as a whole (Van Wyk, 1991:3). Research by Simmons (1978:39) has shown that training could be the most effective means to provide basic skills and information in developing countries. With the recent emphasis on poverty, skill shortages and other related problem areas in poor rural communities, Botha (1991:1) argues that the contribution of training towards addressing these problems is vital. Meanwhile, Van Wyk (1991:3) concludes that education and training are central to economic growth and development and are the main determinants for the formation of human capital.

There seems to be little doubt that in the most general sense, more training in the agricultural sector does lead to higher income from agricultural practices,<sup>22</sup> which are embodied and disembodied by the technical progress.<sup>23</sup> The problem related to training and agricultural income is also examined by Trotter (1987:335-340).

An assessment of the economic contribution of training skills has always been a virtually impossible task (Contogiannis and Peter, 1988:68). However, there is little doubt that human investment is a source of wealth for the country as a whole and it should be considered as part of the socio-economic responsibility for every one in the society (Van Wyk, 1991:3). Progress depends not only on expenditures on equipment and machinery but also on people. Investment in people makes it possible to take advantage of technical progress and to continue that progress (Botha, 1991:1).

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22 See e.g. Becker, 1965:493-517 and Schultz, 1962:1-5.

23 Provided by Solow, 1957:314-318.

There are a number of methods by which training could be evaluated, one of them is the utilisation of cost-benefit analysis.<sup>24</sup> The main benefit to firm/society is that productivity in general is increased. This implies that the *per capita* income of a country or income of the firm is increased to fulfill the necessary requirements for economic development (Van Wyk, 1991:3). It becomes clear that training improves the quality of life and can boost the productivity of a firm as a whole to sustain economic growth and development (Contogiannis and Peter, 1988:69), and where the relationship between training and development could be determined.

In order to assess the relationship between training and agricultural development a cultural approach is developed following Hoffmann and Vieira (1983:39-50) as given in equation (18) appendix (A<sub>4</sub>).

$$y_i = \alpha + \beta x_i + \epsilon_i \quad (18)$$

where:  $y_i$  = *per capita* income;  
 $x_i$  = number of literate farmers;  
 $\alpha$  = constant term;  
 $\beta$  = regression coefficient, and  
 $\epsilon_i$  = error.

A sample of 66 small and medium farmers from the two districts (Madikwe and Taung) was used to investigate the relationship between training and agricultural growth in the region. A stratified random sampling approach was used to select the farmers who operate in these two districts by using modern inputs. The stratification was done based on two socio-economic characteristics, namely level of training and land productivity (income). Data was collected as part of an impact evaluation of training effects on the agricultural growth. The final estimated regression results are given in equation (19).

$$\hat{y}_i = 39,484 + 0,084 x_i \quad (19)$$

$$t = -33,655; \quad R^2 = 0,784; \quad DW = 2,03; \quad i = 0 \\ (-6,87)$$

The positive sign of the training variable indicates that the level of training has a positive impact on the agricultural growth for development. The value of the t statistic indicates that the training variable is statistically significant at the 1 percent

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24 Discussed by various authors e.g. Steyn, 1991:2; Van Wyk, 1991:3 and Botha, 1991.

level. The coefficient of determination statistic ( $R^2$ ) is also statistically significant at the 1 percent level, and indicates that more than 78 percent of variations in the development of the agricultural sector in the area of study could be attributed to variations in training. The Durbin-Watson statistic (DW) was significant at the 5 percent level. Its low value shows the absence of autocorrelation. The low levels of output in the agricultural sector is related to the low level of training. A good level of training can increase the productivity of labour by affecting at least certain spheres of the agricultural production.

## 5.5 CONCLUSION

The aim of this chapter was to provide and describe the importance of domestic resource cost calculations, the negative impacts of the population pressure in the agricultural sector and the relevance of training to promote economic development.

The domestic resource cost calculations provides a framework within which more effective agricultural development policy instruments could be designed to promote the appropriate cash crops by small scale farmers in the area of study. The regional allocation of crops at district levels should be done selectively by assessing the relative benefits and costs of production of the different crops considered.

An economic activity is socially profitable when its domestic resource cost (DRC) is less than the shadow price in foreign exchange. The domestic resource cost is termed unprofitable when its net social productivity (NSP) is positive.

Although an approach could be developed where resources determine economic development, a principal factor limiting resources in the agricultural sector for its development is the population growth. To avoid the population pressure on the agricultural sector a control of its growth rate is vital.

Training of the local people could be the most effective way to promote productivity. A country can invest in its people through training to enhance the productivity capacity of the individuals and society as a whole. Training is central to economic growth and development and it is the main determinant for the formation of human capital.

## **CHAPTER SIX**

### ***DATA COLLECTION PROCEDURE***

#### **6.1 INTRODUCTION**

In chapters 2, 3 and 4 of this study, different models of agricultural sector analysis were provided followed by the description of the regional economy and the agricultural development policy.

This chapter presents a description of the data collection procedure of this study. The chapter is divided into seven main sections as follows: planning of the survey, the questionnaire, sample framework, sample size, differentiation in sample, reasons for bias and sampling errors.

Although many people were hesitant to express their true perception and understanding in supplying information to strangers, some of them were willing to do so. Great pains were taken at all stages of the planning of the survey to create an atmosphere of mutual trust between the research team and the community members, which has been the most important part of the process of data collection. This was done by guaranteeing the confidentiality of the research interviews to the respondents. The annual data for 1978-91 is used in this study.

#### **6.2 PLANNING OF THE SURVEY**

The planning of the survey begun with the literature survey of both subsistence and commercial agriculture in general and of the African agricultural sector in particular. The first step in the planning of the surveys was the reconnaissance of the study area including all twelve districts. This was done by discussions with the agricultural communities, extension officers, community development officers, traditional and non-traditional leaders and many other small and large scale agricultural producers. The second step was to carry out the survey which covers the two districts (Madikwe and Taung) in the area of study on the basis of information obtained from a pre-survey and the paucity of the available data with respect to the development of the agricultural sector in the area of study. Figure 4 reflects the spatial distribution of the population in the area as provided in the 1985 census. It shows the main centres where the planning and execution of the survey was possible.

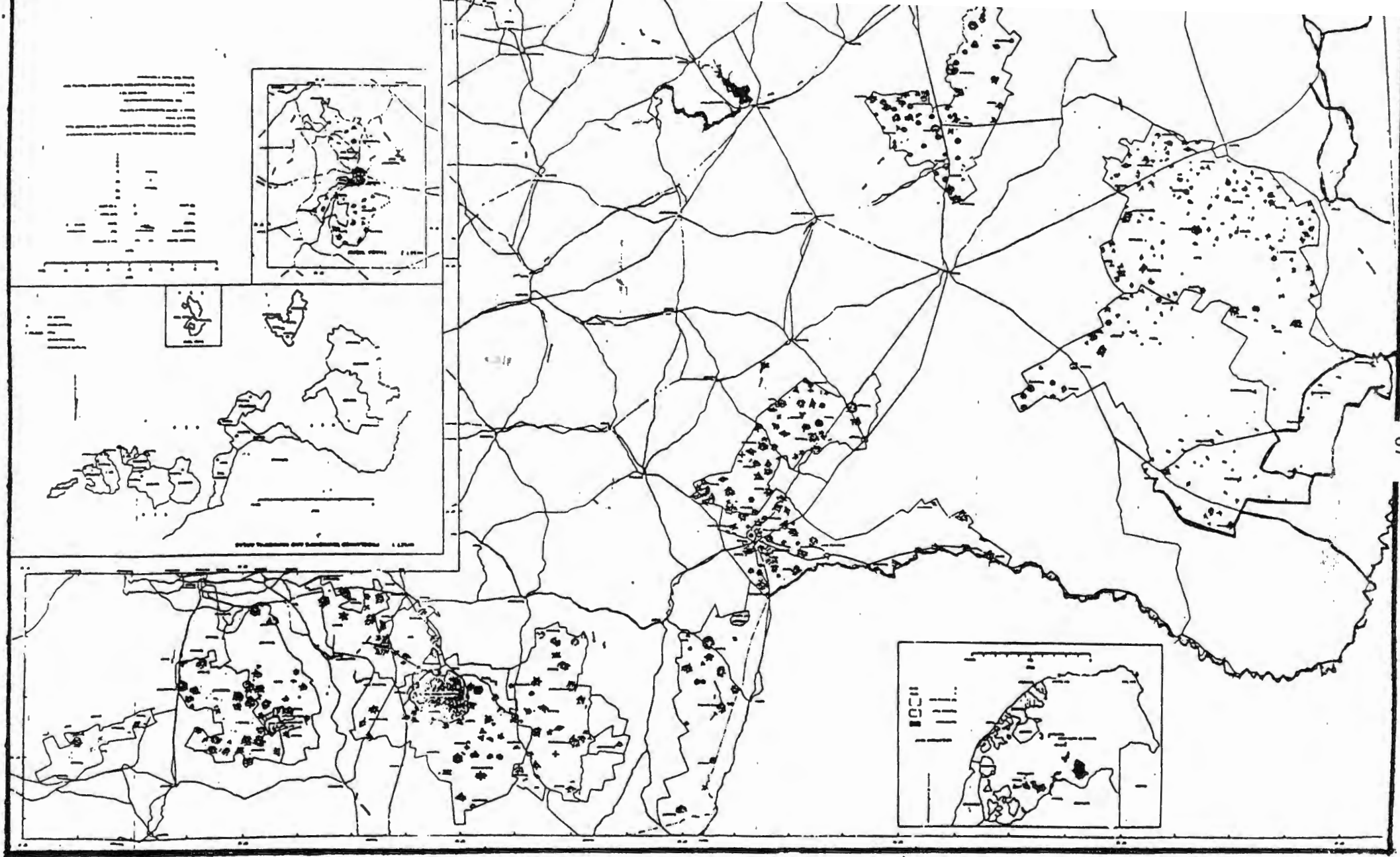


FIGURE 4: Republic of Bophuthatswana population distribution in 1985.

Although some of the districts of the area of study have some agricultural growth potential, no attempt was made to divide the country into areas according to the differences in growth potential. Differentiation between the districts was not necessary since the macro-economic growth potential for the area is considered in this research. In some areas cattle production has been able to compete with crop production due to the lack of direct incentives for crop production. As a result, small and large stock have replaced extensive natural pastures and have forced producers to shift to a more productive cattle production system, which means that both cattle and crop production was considered in the planning of the survey. Finally a questionnaire was developed to obtain the information for this study...

### **6.3 THE QUESTIONNAIRE**

The questionnaire used in this study is intended to determine the needs that people express and could be called an "Actual Needs Survey". This is an ideal instrument for the realisation of this study, because it contains all the information needed about the participants (see appendix A<sub>2</sub>).

Although criticism on the questionnaire is possible, it is generally accepted that it could be completed by experienced enumerators within two hours. Experience from many surveys conducted has shown that with few exceptions, most respondents welcomed the opportunity to discuss their situations, problems, aspirations and differences with the research team. Most of the respondents enjoy the rare occasions of expressing their opinions on a range of development issues, although some of them were reluctant to do so. The questionnaires were administered by Agrigor's qualified and experienced community development and extension officers, who helped in the process of the survey conducted in each district of the area being studied. The results of the questionnaire are provided in appendix A<sub>3</sub>.

#### **6.3.1 Observations from the questionnaire**

These observations are mostly made for some important variables which were not used in the process of model formulation in this study. Looking at the results of the questionnaire, the following comments could be made:

It appears that the head of the house in the area studied are mainly women (female). The number of men interviewed as head of the house were less than the number of females interviewed.

Estimated average age of the head of house in the area is 45 years of age and older. Meaning that the most of the young heads of houses are working at various places, including the mines. The average number of years spent at school is almost 10 years, and the average standard passed by most people interview is standard 8. It seems that most people in the area studied are not employed. For those employed, the average income per month is almost R50,00.

The average number of years spent at school by the wives in the area is 10, and the average standard passed is 9. Very few people have a piece of arable land. Those that have land, generally have less than one hectare (1 ha) on average.

Water is a big problem in the area of study. Generally water is clean but it is quite far from the houses. The main cooking facility is an open fire and the average distance to wood supply is almost 10 km. Cattle farming is of great importance for all farmers in the area. The average numbers of cattle per farmer is 65 for small and 300 head for large farmers (see appendix A<sub>3</sub>).

#### 6.4 *SAMPLE FRAMEWORK*

Because of the number of households in the area of study it was not feasible to interview everybody. A probability sampling procedure was employed whereby the results of the survey could reliably be generalised for the total population of farmers in the area (Ray, 1989:11).

The sample framework survey results as reported in this section were obtained from the nation wide community survey. The study sampled 972 households of farmers in total and of which 315 were large scale farmers and 657 small scale farmers. This sample is significant at the 95 percent confidence level (see section 6.7). In other words, this explains that it is possible for the results to be meaningful at a 5 percent level of all points of the figures quoted in the sample.

The number of interviews conducted in each district varied from one village to another depending on the total population of each village. The population statistics were used from the latest Bophuthatswana population census conducted in 1985. Population distribution in 1985 is shown in figure 5. Meanwhile, the corresponding data on the population census was also projected using an estimated population growth rate of 2,8 percent to arrive at the *de jure* population data needed for this study sample (see table 12).

## 6.5 THE SAMPLE SIZE

In order to decide on the sample size for this research, the knowledge of different statistics was necessary, and in which three important statistics were considered (see e.g. Murray, 1976:75-138) namely:

1. the distribution of the population statistic;
2. the distribution of the sample statistic, and
3. the variance of the population statistic.

Following Fenyes (1982:19-21) once these three statistics are known, the study sample size can be calculated using equation (20).

$$P = c.w \quad (20)$$

where:  $p$  = precision (accuracy);  
 $c$  = confidence coefficient; and  
 $w$  = standard deviation of the estimator.

According to Hoffmann and Vieira (1983:23-26) a mean of a simple random sample from an infinite population is asymptotically normal when  $n > 30$  where  $n$  represents the sample size. This is a special case of the central limit theorem which confirms that the sample mean will approximate the normal distribution when  $n$  approaches infinite, where  $n$  is the sample size (McClave and Benson, 1979:198-199). However, these conditions hold true for an unknown population variance when a large sample is taken from a population which approaches infinity if some estimations of the variance  $\sigma^2$  is possible and can be replaced by  $s^2$  (McClave and Benson, 1979:54-55). On the other hand, Harry (1986:35) argues that  $s^2$  can be estimated using equation (21).

$$s^2 = \frac{\Sigma (x - \bar{x})}{n-1} \quad (21)$$

where:  $s^2$  = variance of a known population;  
 $\Sigma$  = sum of;  
 $x$  = observations;  
 $\bar{x}$  = mean or average, and  
 $n-1$  = degrees of freedom.

Fenyés (1982:20) uses  $R^2$  to represent a crude estimate of the range of the estimator. Therefore, following the above approach, the sample size for this study is calculated using equation (22).

$$n = \frac{(cs)^2}{p} \quad (22)$$

where:  $n$  = sample size;

$c$  = confidence coefficient, which can be taken to be 2 for a confidence level of 95%;<sup>25</sup>

$s$  = crude estimate of estimator of  $w$ , and

$p$  = precision.

**TABLE 12: Sample framework and size of farming operations in Madikwe and Taung districts, 1991.**

Interval class (ha)	Population (1)	Sample size (n)	Variation (%)
0 - 5	900	36	4,00
5 - 10	850	21	2,47
10 - 15	710	17	2,39
15 - 20	518	15	2,89
20 - 25	388	13	3,35
25 - 30	330	11	3,33
30 - 35	288	10	3,47
35 - 40	235	10	4,25
40 - 45	210	9	4,28
45 - 50	196	9	4,59
50+	147	8	5,44
Total	4 772	159	
Average	433,818	14,454	3,33

Source: Data from the survey.

1 Estimated population of farmers per interval class in both districts.

25 The confidence coefficient of 2 has been used to reduce the calculations in the sample used.

Using the correction factor, this formula can be written as expressed in equation (23).

$$n = \frac{N(cs)}{Np^2 + (cs)^2} \quad (23)$$

where:  $n$  = sample size;  
 $N$  = population size;  
 $c$  = confidence coefficient;  
 $s$  = crude estimate of estimator of  $w$ , and  
 $p$  = precision.

Equation (23) may be rewritten to have a new formula (see equation (24)).

$$n = \frac{N \left( c \frac{\hat{R}}{w} \right)^2}{Np^2 + \left( c \frac{\hat{R}}{w} \right)^2} \quad (24)$$

where:  $n$  = sample size;  
 $N$  = population size;  
 $c$  = confidence coefficient;  
 $\hat{R}/w$  = estimator of  $\sigma$ ,  $w$  depends on the preliminary sample size, and  
 $p$  = precision.

Equation (24) clearly shows that the study sample<sup>s</sup> can be calculated by using the necessary predictions regarding the required levels of precision, confidence intervals and the range. According to McClave and Benson (1979:239) the required measurements to be included in the study sample should be determined beforehand.

Furthermore, it was also felt that the variables on which the calculations could be based should be determined at the same time. Therefore, it was necessary to base the calculations on the average of the total income of the producers. Prior to this procedure, income of the producers is supposed to start from R0,00 to R10,000; which explains the actual sampling range of incomes of the farmers. An average estimate of  $R/w$  is then R1 377 with a confidence coefficient  $c$  equal to 2, at a probability level of 95 percent, which was assumed as being satisfactory with a precision  $p$  of plus or minus R200,00 per farmer.

Following these decisions regarding the required confidence intervals, the range and the precision, the required sample size for this study can be calculated following equation (24), and where the selected variables are namely:

$$N = 972 \text{ farmers/producers}$$

$$c = 2$$

$$\frac{\hat{R}}{w} = R1\ 377$$

$$p = R200$$

Replacing these elements in equation (24), the study sample size is thus  $n = 159$  farmers, who were interviewed and finally analysed by this study. This would mean that with a sample size of 159 farmers, there is a 95 percent chance that the average total income of the farmers in the sample will be within R200,00 of the actual income of the population investigated in the area of study.

## 6.6 *SAMPLE UNIT*

The sample unit was defined as a household, which in the case of this study was a farmer/producer. Normally, it is a person who depends on an income from agriculture and related agricultural activities. The interviews were conducted with the head of the household (male or female) but in their absence, consideration was given to an elder son or daughter. The reason being that the head of the household is the principal decision-maker in all aspects including home expenditures.

All the information contained in this chapter was generated to investigate specifically the role of agriculture for accelerated development in the study area and not in its districts. This means that regional variations and differences are not reported in this research as they do not constitute the focus of this investigation. The research did finally cover the former Bophuthatswana as a whole.

## 6.7 *DIFFERENTIATION IN SAMPLE*

Good information can be used in business activities as a basis for developing policy formulation, analysis and control in the process of economic growth and development (Neiswanger, 1979:20-22). The economist has been analysing the economic behaviour, relations and contexts in new approaches by using more mathematics. This procedure has been applied in an effort to shed some added light

on the complexities of the modern economic development theory aimed at testing the significance of the hypothesis derived from this modern theory.

In order to test the hypothesis of this study, the sample was designed to cover the two main groups of the stratified sample of farmers, namely subsistence and commercial farmers. The classification of farmers as provided in the literature survey, do not explain the difference between farmers in terms of their involvement in the economy. More especially when it comes to the number of livestock per farmer, since there are some subsistence farmers with a big number of livestock, they still cannot supply for the markets as commercial farmers do supply.

In the survey conducted by this research, it was found that it would be more accurate to have such a classification according to the number of livestock. This classification is defined in the following manner:

1. subsistence farmers are those households consisting of the following: foodplots, one or two hectares of field crops, up to 20 chickens, and up to 40 head of cattle, goats or sheep, and
2. commercial farmers are those households consisting of any of the following: more than one hectare of field crops, more than 40 head of cattle and more than 40 goats or sheep.

The number of livestock per category of farmers was adjusted in the process of classification of farmers by this study, given the importance of livestock as the main economic activity of almost all the rural dwellers in the area of study. The surveys were started in June 1991 and were completed in April 1992.

## **6.8 REASONS FOR BIAS AND SAMPLING ERRORS**

The possible source of bias and errors in sample surveys are numerous. As an example, Neiswanger (1979:109) points out that the definition of a sample itself, the questionnaire, methods of interviewing and the mechanisms of operating the study sample surveys are often the source of different bias and errors. In order to avoid them, those involved in the process of data collection have to be constantly on the alert for such situations.

## 6.9 VARIATIONS IN DATA

This research considers the data as an element or factor that provides a description about particular conditions and facts which are investigated in a population at a given point in time. Although such description is relevant and true, it might not give a thorough account of the dynamics of the expected socio-economic situation. Surveys are also unable to provide a detailed account of all possible future conditions such as a very good or very bad agricultural year, and the effects that such conditions could have in the determination of socio-economic relations (May *et al.*, 1989:2). Therefore, the data presented in this research must be considered as a necessary partial description of the role of agriculture for development of the area of study.

## 6.10 CONCLUSION

The immediate objective of this chapter was to describe the ways in which the study sample was carried out to investigate the role of agriculture for accelerated development in the area of study. The sample population was defined as all the farmers/producers living in the same tribal authority areas or villages. Meanwhile, the sample unit was a household. The interviews were conducted with the head of the household, whether male or female. In their absence, the eldest son/daughter was considered for the interviews. The data was collected by means of a questionnaire, known as an "Actual Needs Survey". A total number of 972 farmers or respondents were considered at the beginning of the surveys, but this study managed to interview 159 respondents which represents the sample size for this research.

A strategy of multiple methods or research was used which includes a literature survey for both subsistence and commercial agriculture in general and the African agricultural sector literature in particular,<sup>26</sup> and interviews with both the community members and the farmers based on their levels of development and progress in agriculture.<sup>27</sup> A probability sampling technique was used whereby the results of the surveys could be generalised for all the farmers of the area studied. Farmers are classified into two groups, namely subsistence and commercial, this in order to test the hypothesis of this research.

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26 See e.g. chapter 2, page 3-20.

27 Made through surveys conducted with the farmers.

## ***CHAPTER SEVEN***

### ***MATHEMATICAL FORMULATION OF THE MODEL***

#### ***7.1 INTRODUCTION***

Recently, many countries with similar resource endowments have experienced differences in their economic growth based on the different stages of economic development, although such countries might have different approaches to the developmental process (Tweeten, 1989:1).

This chapter presents a complete description of the model developed in this study. An overview of the model structure was provided in chapter 5. Although an explanation of the mathematical programming model is given, the model is provided from an econometric viewpoint. In this chapter, the structural equations of the model are developed and presented to test with the data from three of the major crops of the area of study, namely maize, wheat and sorghum. The chapter is divided into four sections, namely measuring economic progress, the component of the model, data requirements for the model and the model formulation.

#### ***7.2 MEASURING ECONOMIC PROGRESS***

Economic progress is always measured by the application of a statistical or mathematical model of economic change, with emphasis on mathematical programming and econometric methods. This is done by analysing the economic behaviour in which the living standards of the people are included (Neiswanger, 1979:22). Besides the models of change, this research also uses a macro-economic approach to analyse the role of agriculture for accelerated development in the area of study. This is a process of providing better information leading to the improvement of investment decisions concerning the national agricultural sector.

The ultimate objective of the models developed in this research is to analyse the role of the agricultural sector for the economic development of the area of study. On the other hand, the models provide relevant information to administrators, planners, managers and policy-makers to improve their decisions on resource allocations in the agricultural sector to meet the national goals. The importance of these models

(mathematical programming and econometric) is described in the following sections.<sup>28</sup>

### 7.2.1 *Mathematical programming models*

Mathematical programming models have been widely used in the studies of the agricultural development process (see e.g. Lyne *et al.* (1991:44-48).

This technique constitutes a logically consistent method for evaluating alternative economic development policies (Epplin and Stoecker, 1989:212). The approach consists of formal procedures for optimising an objective function subject to numerous constraints/restrictions, such as those imposed by scarce resources. The advantage of mathematical programming models lies in the *ex-ante* measurements of the development impact rather than the *ex-post* determination (Hazell and Scandizzo, 1974:239-242).

Mathematical programming models can be constructed to quantify the economic consequences of alternative policies on resource use, production and the relative well-being of the producers and consumers without detailed time series data (Kirsten and Van Zyl, 1990:213; Van Zyl, 1989:205; Epplin and Stoecker, 1989:212; Lyne *et al.*, 1989:192-193). These models could be supplemented by econometric models.

### 7.2.2 *Econometric models*

The development of regional economic analysis has become more important with the growing interest in the use of econometric models (Kirsten and Van Zyl, 1990:213). Hoffmann and Vieira (1983:80-85) state that this technique involves a set of multiple equations that provide and describe at the same time the structure of the local economy, while predicting variables such as income, production patterns and employment. Regression analysis is used in these models to determine relationships between the variables of the models (Tweeten, 1989:12).

Ideally, during the specification stage, the model construction should not be influenced by the availability of data or other constraints in specifying the mathematical structure or functional form of the model (Tweeten, 1989:13).

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28 See e.g. Kirsten and Van Zyl, 1990:213.

Econometric models have the potential to facilitate an impact analysis of the local economy (Kirsten and Van Zyl, 1990:213).

Econometric models are aimed at describing and providing the actual structure of the agricultural sector for economic growth and development in the area of study. Statistical problems such as heteroscedasticity,<sup>29</sup> autocorrelation and multicollinearity might influence the magnitude of the regression coefficients. This might complicate the application of this method. On the other hand, econometric models have the ability to provide an impact analysis on the agricultural sector of a country. Given the description of the model above, the components could be determined as described in the following section.

### **7.3 COMPONENTS OF A MODEL**

This section provides the components of the model by determining those variables which are relevant in the mathematical formulation of the model. It provides for various kinds of crops (maize, wheat and sorghum) considered for analysis by this research. Multiple regression analysis is used which could be applied for the analysis of any other crop produced in the area being studied.

#### **7.3.1 *Dependent variable of the model***

The dependent variable is defined as the total annual production or annual output (y) of each crop produced in the area of study such as maize, wheat and sorghum. It can also represent the total annual value of these crops. As such y depends on the different independent variables.<sup>2</sup>

#### **7.3.2 *Independent variables of the model***

Independent variables are resources or inputs used in the production process of crops. Through a more effective combination of these resources/inputs, crop production and output can be increased by farmers in the area of study. Among those variables the most common are land, labour and capital e.g. equipment, fertiliser, seeds and the income, including the yield (in tons per hectare) and the costs of production. The econometric model in this study is composed of at least six

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29 See appendix for treatment of statistical problems of the model, page 186.

independent variables (see e.g. 7.4.3.5). This is important to give a good picture of the level of agricultural development in the area of study.

### **7.3.3 *Income component***

In this research, household income is perceived as a flow of cash crops and livestock, wages, remittances and pensions used regularly by households for their survival. Income retained in savings and from migration is not included in the subsistence of the households as household income. The main problem with migrant remittances is that it cannot be considered as a consistent flow of the household income, because monthly variations are found.

Household income is used in this model as an independent variable because it constitutes the basic means for self-sufficiency, self-reliance and investment in the rural areas, although it depends on the output ( $y$ ).

The measurement of the household income is always difficult and sensitive because most of the rural households are reluctant to disclose their income and its sources. Furthermore, the consumption of home produced agricultural commodities is difficult to value. Bearing this in mind, income of the rural households were adjusted by adding some estimated values to compensate to those undisclosed sources of income.

### **7.3.4 *The yield component***

The yield component as an independent variable is needed in the model because it shows what is actually happening in the agricultural sector in the area of study in terms of yield per hectare. Crop yields are a function of a number of variables such as crop variety, fertiliser application, irrigation and weather conditions. The large number of factors affecting crop yields and the interaction effects that can occur among them makes the task of modelling rather difficult.

Among those factors influencing crop yields, fertiliser has been the most important element in stimulating productivity. With the available data, adjustments in the productivity can be made by combining all the effects produced by fertiliser together with other relevant factors of agricultural production.

To generate the yield of the different crops endogenously in the model, this research uses the quantity of fertiliser Nitrogen (N), Phosphorous (P) and Potassium (K) or

NPK applied in the cultivated area of the crop. In situations where biological technologies are crucial, the model cannot introduce yield-nutrient response data in order to be able to evaluate the optimum nutrient levels and the relationship among crop variety, fertiliser and yields. The data used is the experimental data on the yield responses.

The large variation in crop yield is often due to variations in the dose of nitrogen. The present case considers nitrogen as the basic factor or element determining crop yields. The amount of fertiliser applied in crop production is a decision variable which depends on a number of variables such as capital availability, the farmer's decisions, prices of the products and inputs.

The livestock yields are assumed constant throughout the model formulation. The reason being that many of the factors influencing livestock yields isn't as quantifiable or measurable as it is in the case of crop production.

#### **7.4 THE DATA REQUIREMENTS FOR THE MODEL**

The implementation of the model requires a wide range of data which makes it necessary to use quite diverse sources of data. Basically, three categories of data are used in the formulation of the model, namely initial conditions, constant parameters, and timevarying parameters or exogenous variables. The data requirements and sources that fall in each category are described in the following sections.

##### **7.4.1 Initial conditions**

In order to start with the first cycle of the model formulation, it is necessary to have the initial conditions or constraints to crop production in the area of study. These include land, labour and capital. The initial conditions for these factors of production are derived from the "Information Symposium on the State of Agriculture in Bophuthatswana" (Bophuthatswana Marketing Board, 1987:29-227). These also include flexibility conditions for crops and pasture derived from the historical data and information on cultivated area also provided in the same document.

##### **7.4.2 Constant parameters**

The constant parameters as expressed by the model formulation are related to production technology, input application rates, rates of changes in crop and price

incentives. The main reason for considering these parameters as constants is the lack of adequate data needed to analyse them as variables of the model. Some of these parameters include pasture and beef activities, input application rates of various crops and livestock, livestock yields and various rates of changes in them.

#### 7.4.3 *Time-varying parameters or exogenous variables*

By its very nature, the model implemented is capable only to provide a conditional estimation since its results depend on a given set of assumptions concerning the behaviour of the time-varying parameters and exogenous variables which are determined on the basis of off-line projection. This category includes prices for products and inputs, labour wage rates, proportion of the land on which farm size can be grouped, number of the farms, population growth rates and working time equivalent to labour. Most of these projections are based on historical data (Bophuthatswana Marketing Board, 1987:29-227).

### 7.5 *ELASTICITY ESTIMATES FOR CROPS*

It is generally postulated that the expected producer prices, expected input prices, weather conditions and technology of production are the main determinants of the supply response in agriculture.<sup>30</sup> This general formulation could be taken as the basis for the estimates of the elasticities of output for selected crops of this study. The peculiarities of the former Bophuthatswana agricultural sector are also taken into consideration.

Available evidence from many studies indicates that in aggregate there is limited use of modern inputs such as fertiliser, pesticides and high-yielding varieties particularly by most peasant farmers in the area.<sup>31</sup> Empirical evidence on the determinants of the crop supply response is therefore important to identify the major factors of production affecting crop performance (Cleasby *et al.*, 1992:1).

The price elasticities of supply estimated directly from the model are compared to the reality of agricultural situation in the area of study. The policy implications of the results are analysed in relation to the potential in agricultural supply.<sup>32</sup>

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30 See e.g. Nerlove, 1956:499-506; Bond, 1985:58-66 and Tshibaka, 1986:

31 Observed by Gittens, 1991:26 and Kongolo, 1992:10.

32 See Cleasby *et al.*, 1993:4 for elasticity formula used.

## 7.6 *STRUCTURING FOR MARKETING OF MAIZE, WHEAT AND SORGHUM*

The maize and wheat outputs in the area of study were marketed according to a single channel fixed price scheme by the Bophuthatswana Marketing Board. Since 1987 the producer price has varied inversely with the quantities of annual production.<sup>33</sup> The Marketing Board and its appointed agents are the sole buyers and sellers of all maize and wheat outputs produced in the former Bophuthatswana. Evidence from prices by the Marketing Board has shown that the netto wheat producer price is highly in contrast to the netto maize producer price (see appendix B<sub>2</sub>). The maize producer price is less attractive as compared to the wheat producer price (see appendix B<sub>1</sub>), nothing could influence this policy since the Marketing Board has the sole statutory monopoly in fixing the commodities prices in the country.

An advantage for sorghum producers is that its output is not marketed through a single channel fixed price scheme as is the case for maize and wheat. Most sorghum producers in the area of study have a choice to sell their products to private buyers directly. In this case the buyer would be paying an estimated levy of R25,00/ton for a stabilisation fund to the Marketing Board. Contrary to this, they can still sell their products to Marketing Board at a floor price (minimum producer price) which is also competitive as compared to that of maize.

The Bophuthatswana Marketing Board has the potential to institute a policy of price discrimination on crops produced in the country. The domestic producer prices of crops are realised from sales in the domestic and export markets.<sup>34</sup> The Marketing Board pays to producers a fixed price for deliveries of the agricultural commodities. If the prices are above the netto export realisation prices, the Board can compensate for the resulting export losses by raising the domestic selling prices.

## 7.7 *AGRICULTURAL PRICE INTERVENTIONS*

In this research it is assumed that the economy in the area of study is small and open, and that prices, the trade (marketing) regime and exchange rate policies affect the structure of incentives facing the farm sector and also the agricultural sector as a whole. This economy produces domestic, import-competing and export-competing commodities, unfortunately the price data of these commodities is limited.

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33 Interview with the Bophuthatswana Marketing Board, 1993.

34 See section 7.5.

The prices of these commodities are primarily determined by the domestic demand and supply schedules. Producer prices data is also limited. Crops such as maize and wheat, which are exclusively produced by peasant farmers have no parallel markets, except the only Bophuthatswana Agricultural Marketing Board.<sup>35</sup>

Analytically it is convenient to use the general equilibrium in the domestic market to determine the equilibrium price relationship between commodities.<sup>36</sup> An equilibrium in the domestic market implies that the demand and supply of goods ( $D_d$  and  $S_d$ ) are equal.

This is expressed in equation (25).

$$D_d = S_d \quad (25)$$

where the domestic demand and supply could be fully expressed as given in equations (26) and (27).

$$D_d = D_d (P_m/P_d, P_x/P_d, y); \text{ and} \quad (26)$$

$$S_d = S_d (P_m/P_d, P_x/P_d, z, t) \quad (27)$$

where:  $P_m$  = domestic price of importable goods;  
 $P_x$  = domestic price of exportable goods;  
 $P_d$  = domestic price in domestic market;  
 $y$  = real income of farmers;  
 $z$  = productive resource vector, and  
 $t$  = technology.

The variables  $y$ ,  $z$  and  $t$  can be held constant to examine the comparative static properties of the model where the primary interest is the movement of relative prices.<sup>37</sup>

Differentiating both equations (26) and (27) in terms of  $P_m$  and  $P_d$ , equations (28) and (29) are obtained where the elasticity coefficients are provided.

$$D_d = \alpha_m (\hat{P}_m - \hat{P}_d) + \alpha_x (\hat{P}_x - \hat{P}_d) \quad (28)$$

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35 See section 7.5.

36 See e.g. Tshibaka, 1986:31 for more comments.

37 See appendix for treatment of statistical problems of the model, page 186.

$$S_d = \mu_m (\hat{P}_m - \hat{P}_d) + \mu_x (\hat{P}_x - \hat{P}_d) \quad (29)$$

In these equations,  $\alpha_m$  and  $\alpha_x$  are the elasticities of demand and  $\mu_m$  and  $\mu_x$  are also the elasticities of supply with respect to the relative prices; the hat (^) over the variable p indicates a percentage change.

This brief demonstration shows how trade, exchange rate and other price policies could affect the structure of the relative prices facing the national economy through their effects on domestic prices of agricultural commodities.

## 7.8 CROP SUPPLY RESPONSE FUNCTION

The three crops selected for this study include maize, wheat and sorghum. The Bophuthatswana experience has shown that sorghum as a maize substitute is competing with maize together with wheat in terms of producer prices as incentives to farmers. The crop supply function for both commodities can be formally written as given in equation (30).

$$Q_1 = f(q_{1-1}, q_1, q_f, q_{1a}, p_i, q_r, q_y, q_t) \quad (30)$$

where:  $Q_1$  = quantity of output for crop concerned;  
 $q_{1-1}$  = quantity of land during the period  $t_{-1}$ ;  
 $q_1$  = area of land used presently;  
 $q_f$  = quantity of fertiliser used;  
 $q_{1a}$  = number of labourers;  
 $p_i$  = expected producer price for crop concerned;  
 $q_r$  = quantity of rain in mm;  
 $q_y$  = tons per hectare (yield/ha), and  
 $q_t$  = technology.

Crop supply refers to the quantities offered for sale in the market at the different prices. The total production is treated as the relevant dependent variable ( $Q_i$ ). Conceptually in the most general sense, the total production is viewed as the total supply in the market, if the total demand includes that of the farm household.<sup>38</sup>

It is not known exactly how farmers form their expectations of crop prices. The estimates of supply obtained by using the last year's prices should be underestimated

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38 See appendix for treatment of statistical problems of the model, page 186.

by farmers. The prices of many years and the weight given to them in the preceding years could decline over time.<sup>39</sup>

Two price expectation models were tried by Tshibaka (1986:53) in his study of aggregate supply response of crops in Zaire. One of them was selected for this study. This price explains farmer's expectations based on the last cropping season prices which they would like to prevail for the current season.<sup>40</sup>

The expected price under this condition is given in equation (31).

$$P_1 = P_{t-1} \quad (31).$$

The traditional approach of considering the preceding year's producer price is adopted in this study, and is trended using the consumer price index as deflator, to avoid any multicollinearity problem between the trend and other explanatory variables.

The two variables (labour and technology) included in the formal model (30) have a dominant role to play in crop supply. The lack of data on these two variables does not allow for a detailed description of how they can affect the supply of crops in the area of study. For this reason both variables were considered as constant in the model. In the same manner, data on fuel consumption and equipment was also not available. This has led this study to reconsider the formulation of the formal equation by providing some general considerations in the model as discussed in the following section (7.9).

## 7.9 *CONSIDERATIONS ON THE MODEL*

The empirical approach to the modelling procedure used in this research follows E1-Ghonemy (1992:182-184). The model includes a conceptual, linear and Cobb-Douglas form as discussed in section 7.8.1. The estimation method used is the Cobb-Douglas production function which, in its logarithmic form is nonlinear and was used for the empirical analysis of results.<sup>41</sup>

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39 Explained by Nerlove, 1958:87-111.

40 Explained by Nerlove, 1958:87-111.

41 Described by Gallant and Goebel, 1976:961-967 and Harvey, 1981:182-202.

### 7.9.1 *The conceptual model*

The conceptual form used in this study consists of a functional relationship between one dependent variable ( $y_i$ ) and a number of independent variables ( $x_i$ ). This can be seen in equation (32) and it could be applicable for all the crops selected for this study.

$$y = f(x_i) \quad (32)$$

where:  $y$  = estimated crop production in tons;  
 $f$  = function of ...;  
 $x_i$  = independent variables or inputs, and  
 $i = 1,2,3,\dots n$ .

With an objective of having a clear functionality between the dependent and independent variables in mind, the mathematical model would be applied in the study to have well defined objectives.

This research uses two different mathematical models as provided in the following sections.

### 7.9.2 *Linear model*

The linear model of analysis used in this study has the following form:

$$y = a + \Sigma b_i x_i \quad (33)$$

where:  $y$  = dependent variable;  
 $a$  = constant;  
 $b_i$  = regression coefficients;  
 $x_i$  = independent variable, and  
 $i = 1,2,3,\dots n$ .

The following properties represents the most important characteristics of the linear model form (Heady and Dillon, 1961:38-79):

1. the total product increase at a constant rate;
2. the marginal product is held constant at any level of production;

3. when  $a = 0$ , then a marginal product is equal to the average product, and
4. there are constant returns to scale when  $a = 0$ .

### 7.9.3 *Cobb-Douglas model*

#### 7.9.3.1 *Model specification*

The Cobb-Douglas model which in its logarithmic form is a linear function used in this research has the following general form:

$$y = a\pi x_i^{b_i} \quad (34)$$

where:  $y$  = dependent variable;  
 $a$  = constant;  
 $\pi$  = represents the sum of  $x_i^{b_i}$ ;  
 $x_i$  = independent variable;  
 $b_i$  = partial regression coefficients, and  
 $i = 1, 2, 3, \dots n$ .

For practical purposes, this model is often utilised in its linear or logarithmic form as expressed in equation (35).

$$\text{Log } y = \text{log } a + \sum b_i \text{log } x_i \quad (35)$$

where:  $y$  = dependent variable;  
 $a$  = constant;  
 $b_i$  = partial regression coefficients;  
 $x_i$  = independent variable, and  
 $i = 1, 2, 3, \dots n$ .

#### 7.9.3.2 *Characteristics of the Cobb-Douglas model*

According to De Oliveira (1984:129-149) the following characteristics could be attributed to the Cobb-Douglas model:

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42 Discussed also in 2.3.3.

1. it is linear when it is written in its logarithmic form;
2. elasticities of production are given by its partial regression coefficients expressed by  $b_i$ 's;
3. it facilitates the determination of the type of increases in relation to scale of the production process, which can be observed during the production process itself;
4. it facilitates the process of marginal productivity calculations in a brief manner;
5. the model supposes that all the factors of production are indispensable to the production process. In other words, when any independent variable  $x_i$  is zero, the dependent variable  $y$  will also be zero, and
6. all the isoquants are linear in the production process and are asymptotic to the axis.

### ***7.9.3.3 Limitations and assumptions of the Cobb-Douglas model***

Economic science as a discipline is aimed at looking into the concrete problem by using models as the means of understanding and providing solutions to such problems. Each economic model has always an approximation character due mostly to the different relationships between variables. The following are the limitations of a Cobb-Douglas model as provided by De Oliveira (1984:129-138):

1. gives some degree of knowledge of the problem;
2. the period of time is taken into consideration;
3. provides the divisibility of products and resources;
4. the relationship between prices and products is known, and
5. the level of technology of production used is also known.

These limitations consequently, require the introduction of some simplified presuppositions such as:

1. there exists perfect knowledge of the markets, including the knowledge of resources and products;

2. the level of technology of production and the relationships between resources and products is known;
3. both products and production factors could be divided into small proportions in order to have better conditions for maximisation of the income and which could provide an optimum level in the use of resources;
4. all the resources are completely transformed into products during the period of time in considerations, and
5. resources should be utilised in such a way that better combinations are obtained to maximise farmer's income.

All the presuppositions discussed above may have some complications only when an aggregated production function or model can be used.

#### ***7.9.3.4 Estimates of the production function***

All the production functions have been estimated using data obtained as described in section 7.3. The multiple regression equations have been calculated using the Least-Squares regression.<sup>43</sup>

### ***7.10 CONCLUSION***

The main aim of this chapter was to describe the ways in which the mathematical formulation of the study model could be provided for empirical analysis purposes. The model was formulated with an objective of measuring the economic performance of the farmers including the progress made by the former Bophuthatswana government in promoting the agricultural sector of the economy. It was also expected of the model to provide an impact analysis of the economic behaviour in which the living standards of people are expressed. The ultimate concern of the model developed in this research was to provide an impact analysis of the role of the agriculture for accelerated development in the area based on data up to 1991.

The framework of analysis used is based on econometric models, because they are capable of providing an impact analysis of the regional economy. Econometric models can also describe the actual structure of the agricultural sector by indicating

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43 See Hoffmann and Vieira, 1983:73-104.

needed changes for policy directions. Although econometric problems such as heteroscedasticity, autocorrelation and multicollinearity might influence the application of this method by complicating its use, provisions have been made to deal with the treatment of these problems.

The components of the model have been described as being mainly the dependent and independent variables.<sup>44</sup> The dependent variable defines the total output while the independent variables represent the inputs used in the production process.

An assumption about the expected producer prices, expected input prices, weather conditions and technology as the main determinants of the output supply response in agriculture has been considered as the basic means for the estimates of the elasticities of supply for the selected crops considered in this study. These crops include maize, wheat and sorghum. Maize and wheat are marketed according to a single channel fixed price scheme, the Bophuthatswana Marketing Board as the sole buyer and seller. Grain sorghum can be marketed through the parallel or official market in the country depending on the farmers' choice.

Some of the most important variables included in the model were capital, land, labour, producer price, technology, rainfall, yield per hectare and a trend variable. Hence the model was composed of six independent variables.<sup>45</sup>

The formulation of the model required a wide range of data, which was necessary to make use of several diverse sources of information. Basically three types of data were used in the model formulation of this study, namely initial conditions, constant parameters and the time-varying parameters. The model was analysed using the Least-Squares Method. The three main model forms developed were linear,  $\text{Log}_{10}$  and the Cobb-Douglas functions. The empirical results discussed in chapter 8 are based on the linear Cobb-Douglas function.

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44 See section 7.7 for explanation, page 102.

45 Data on labour, technology, fuel consumption and equipment were not available.

## **CHAPTER EIGHT**

### **EMPIRICAL RESULTS AND DISCUSSIONS**

#### **8.1 INTRODUCTION**

This chapter presents the empirical results obtained by operationalising the model developed in the previous chapters. The model structure indicates that information can be obtained which will permit simulation of the results for alternative agricultural development assumptions according to:

1. farm size groups;
2. selected crops, and
3. inputs.

To analyse all the results of the model for the various dimensions was virtually impossible. Considering the objectives of the research, the analysis has been limited to a few selected variables related to production, policy instruments and input utilisation. Two main models were considered in an attempt to analyse the findings of this research, namely linear and nonlinear Cobb-Douglas forms. The selected commodities were maize, wheat and sorghum. The results of the analysis are provided for both large and small farmers in the case of maize and wheat, except the results of sorghum which are given for large farmers only because of the limitations in data on small farmer sorghum producers.

#### **8.2 SELECTION OF THE SUPPLY FUNCTION**

Given the supply response function<sup>46</sup> (equation 30) which adjusts better to the research data, the following statistics were used:

1. a statistic "t" for the significance of the regression coefficients;
2. statistic "F" for analysis of correlation as a whole;
3. statistic ( $R^2$ ) the coefficient of determination, for analysis of the total variations in the explanatory variables included in the model;

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46 See section 7.7, page 102.

4. statistic ( $R^2$ ) the coefficient of adjustment in the production, and
5. the statistic "DW" Durbin Watson for dependent variable.

Some of the characteristics used in the selection of the final functions for empirical production analysis of the crops were the following:

1. the function should be consistent with the nature and relations of production theory; interpretation of the variables should also be consistent with the theory of production as applied in economic theory;
2. the function should include enough explanatory variables to make a contribution to the research, and
3. the explanatory variables included in the model should impact on the study by influencing the situation analysed.

These points were crucial before any individual commodity analysis could be made.

### 8.3 *INDIVIDUAL COMMODITY ANALYSIS*

This section presents the results of maize production by both large and small farmers investigated in this study. Before such analysis could be provided, the findings from some studies on food supply and economic efficiency from other African countries are analysed.

An analysis of F.A.O. data for some 40 African countries has shown no positive correlation between the growth performance of the agricultural sector and food supply. The relationship was positive although a Spearman rank correlation coefficient was rather weak, about 0,42 for the period of 1971-80.<sup>47</sup> Other studies on Sudan and Tanzania emphasised the question of economic efficiency regarding food supply.<sup>48</sup> These studies expressed the view that the marketing channels for commodities were more developed than those serving for food crops. If farmers in some areas specialise in food crop production because the conditions are suitable, they may at the latest stage have no inputs because of interruption in supply.

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47 See Tshibaka, 1986:38.

48 See Franklin *et al.*, 1982:146 for more information.

The problem of infrastructure development of the areas under food production should be dealt with, because it affects food production and the prices of food at the farmer's level and would render both unattractive.<sup>49</sup>

### 8.3.1 *Aggregate production function*

An aggregate production function used in this study as a tool of analysis would help to assess not only changes in the crop supply, but also the implications for farm outputs, farm income and employment. Not only were the prices, inputs/outputs and other data on crop supply needed, but they have to be sufficiently disaggregated to allow meaningful analysis based on a production function model. However, the lack of some data restricts the analysis to crop supply response.

The estimation method described by Gallant and Goebel and which Harvey called the two-step full transform method was used to correct the first autocorrelation.<sup>50</sup> There is little literature on crop supply response studies in this area. Bond found nothing pertaining to Zaire in her extensive review of agricultural response to prices in Sub-Sahara Africa.<sup>51</sup> As a result of this extensive review of agricultural response to prices, estimates of supply elasticities were provided by Bond in her study.

In this study the own-price elasticities of supply have been attempted for all the selected crops analysed, notwithstanding data limitations and the controversies of the supply response model. However, the cross-elasticity of supply has been given to investigate only the conflict between sorghum and maize production in the area studied.

The own-price elasticity indicates the extent to which crop output is affected as a result of a 1 percent change in the crop's own-price, whereas the cross-elasticity gives the impact of a 1 percent change in a competing crop price on the output of the crop. It also indicates whether there may be conflict between the two competing crops in the production process. Maize supply for both large and small farmers in the area is discussed in the following section.

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49 See appendix B<sub>1</sub>, page 192.

50 Discussed by Gallant and Goebel, 1976:961-967 and Harvey, 1981:182-202.

51 Comments by Bond, 1983:51-79.

### 8.3.2 *Maize supply estimates : large and small farmers*

Two forms of the production function have been adjusted to test the data on maize production in this study. Several alternatives were attempted to facilitate the comparison of the results obtained from the different model forms in various ways. Due to the possibility of a high degree of autocorrelation, particularly when dealing with limited time-series data. The full transform method was used to derive the regression coefficients of maize production in the area of study.<sup>52</sup>

The analysis shows that the output of maize is critically determined by the quantity of fertiliser used, quantity of land cultivated, expected producer prices and the rainfall for the large farmers; small farmers maize output was determined by the quantity of land cultivated and the rainfall (see table 13).

Following the model expectations, the regression coefficients of the quantities of fertiliser and rainfall in both equations (A) and (B) of the large farmers display the signs which were not expected. The regression coefficients of yield per hectare ( $Q_y$ ) displays opposite sign than expected in both equations (A) and (B) for both large and small farmers (see table 13).

From the regression results it is clear that the explanatory variables of the model have more positive effects on the output of the large than the small farmers.

The estimate of the own-price elasticities of maize supply were about 0,344 and -0,222 for large and small farmers respectively. The negative sign of the price elasticity of the small farmers indicates that their output was less when compared to the higher price of production process.

By using an aggregate output supply model, Tshibaka estimated the own-price elasticity of maize output of about 0,121 in Zaire's maize supply.<sup>53</sup> Meanwhile, Oyejide made use of the different supply model specification when he estimated the own-price elasticity of maize supply in Nigeria of about 0,251.<sup>54</sup> In the same way,

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52 The Gallant and Goebel, 1976:961-967 and Harvey, 1981:182-202 approach has been used to derive regression coefficients for all selected crops in this study.

53 Calculated by Tshibaka, 1986:59.

54 Estimated by Oyejide, 1986:67-78.

Cleasby *et al.* estimated the own-price elasticity of the yellow maize supply for export in South Africa to be around 0,43.<sup>55</sup>

**TABLE 13: Regression results for maize production in the area of study, 1978-91.**

Independent variables (1)	Dependent variable : ln Q maize			
	Large farmers		Small farmers	
	Equation (A)	Equation (B)	Equation (A)	Equation (B)
Constant	4,756	4,847	2,451	2,463
lnq <sub>L-1</sub>	0,1777 (0,483)	0,218 (0,643)	0,664 (3,405)***	0,568 (4,436)***
lnq <sub>1</sub>	0,468 (1,326)*	0,612 (3,179)***	0,699 (4,423)***	0,714 (4,325)***
lnq <sub>f</sub>	-0,491 (-4,383)***	-0,536 (-4,739)***	-0,138 (-0,614)	-0,147 (-0,528)
lnp <sub>i</sub>	0,335 (1,974)	0,344 (2,228)**	-0,128 (-0,479)	-0,222 (-0,481)
lnq <sub>r</sub>	0,365 (1,434)*	0,346 (1,529)*	-0,321 (-1,483)*	-0,343 (-1,486)*
lnq <sub>y</sub>	0,334 (1,423)*	0,340 (2,516)**	0,137 (0,643)	0,142 (0,649)
trend	-0,468 (0,685)	-0,471 (0,899)	-0,426 (0,662)	-0,433 (0,675)
R <sup>2</sup>	0,864***	0,883***	0,784***	0,793***
R <sup>-2</sup>	0,575	0,587	0,521	0,524
F	4,271***	4,283***	23,580***	26,551***
DW	3,272***	3,322***	2,846**	2,876**
$\rho$	-0,076 (-0,379)	-0,089 (-0,388)	-0,028 (-0,089)	-0,032 (-0,093)

(1) The definition of independent variables is provided in section 7.7. The first step of the two-step full transform method was to estimate the model using the ordinary Least-squares method. The autoregressive parameter  $\rho$  was estimated and its values were not significant.

\*\*\*, \*\* and \* indicate significance at the 1; 5 and 10 percent levels. The numbers in parentheses are t-values.

The estimates of the own-price elasticities of maize supply provided in this study present some useful indications of the impact of change in maize producer prices on its supply in the area of study. The analysis suggests that a change in maize producer prices would have a significant impact on maize output, other things remaining the same.

The comparison of the own-price elasticity estimates on maize output from other studies with those obtained in this research could be misleading. However, the estimates of the own-price elasticities for maize supply of about 0,344 and -0,222 for large and small farmers of the area of study could be regarded as acceptable.

Agricultural price intervention policy measures have been the main policy devices to be used by the government of former Bophuthatswana to effect changes in the agricultural sector and in the economy as a whole. These policy instruments are the most important determinants of the change in crop output. This is because they determine not only the intra- and intersectoral movements of the resources, but they also affect the availability of resources such as foreign exchange earnings.

Following this line of thinking it could be stated that the emphasis given to promote crop output by both large and small farmers in the area of study lies in the allocation of public and private resources to help boost the performance of the food crop subsector. In most cases, the small peasant farmers, the chief producers of food in most rural villages, have little political weight as compared to the large farmers. This has resulted in a biased allocation of resources amongst farmers in the country. It can be said that the efforts to improve food crop production should be directed mainly to large farmers.

The current interest in the agricultural productivity in the area of study should be closely related to the agricultural and political development that would lead to some important reforms. Policies which include cheap credits, little interest rates and even tax breaks could be passed on to improve the small farming sector.<sup>56</sup> By quoting Van Zyl (1986) Cleasby *et al.* observed that the elasticities of substitution in the South African agriculture were very low. An important factor they have attributed to this inflexibility was the lack of competition in the agricultural sector.

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56 See e.g. Cleasby *et al.*, 1993:313 for more comments.

### 8.3.3 *Review*

In general, it can be stated that a Cobb-Douglas model satisfactorily explained the variations in the production of maize by large and small farmers of the samples investigated in the area of study. According to the regression results of the model, it could be stated that the statistical characteristics for all the regression results were satisfactory. The estimated regression coefficients for both equations were statistically significant at the 1, 5 and 10 percent levels. The explanatory variables included in the maize supply models explained not less than 88 and 70 percent of the total variations for both large and small farmers respectively.

Available evidence from the estimated regression coefficients of the maize production function by the small farmers indicated that on the aggregate there is a limited use of intermediate inputs such as fertiliser, pesticides and high-yielding cultivars.

The analysis of the own-price elasticities suggests that a change in maize producer prices could bring about a significant impact in maize outputs of the large farmers. However, the small farmers, the chief producers of food in most rural villages, have little political weight as compared to the large farmers in the area. This has resulted in a biased allocation of resources by a group of small farmers investigated in the area of study.

## 8.4 *WHEAT PRODUCTION : LARGE AND SMALL FARMERS*

This section discusses the empirical results of wheat supply by both farmers studied in this particular area. The economic and statistical importance of regression coefficients and its significance are provided in table 14. The estimation method described by Gallant and Goebel and which Harvey called the two-step full transform method was also used to estimate the regression coefficients.<sup>57</sup>

### 8.4.1 *Statistical results*

Two equations have been adjusted to test the data on wheat production by both large and small farmers of the samples investigated. In both equations (A) and (B) for both groups of farmers, the regression is satisfactory (see table 14, equations (A) and (B)). The regression coefficients for explanatory variables have the expected

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57 See Gallant and Goebel, 1976:961-967 and Harvey, 1981:182-202.

signs and were statistically significant at the 1, 5 and 10 percent levels, as indicated by the t-ratios in the parentheses.

**TABLE 14: Regression results for wheat production in the area of study, 1978-91.**

Independent variables (1)	Dependent variable : $\ln Q$ maize			
	Large farmers		Small farmers	
	Equation (A)	Equation (B)	Equation (A)	Equation (B)
Constant	3,269	3,297	6,471	6,865
$\ln q_{L-1}$	0,466 (2,368)**	0,469 (2,373)**	0,587 (3,413)***	0,618 (3,339)***
$\ln q_1$	-0,287 (-0,568)	-0,278 (-0,474)*	0,569 (3,587)***	0,572 (2,793)**
$\ln q_f$	0,556 (3,070)***	0,568 (3,177)***	-0,294 (-0,089)	-0,299 (-0,092)
$\ln p_i$	0,333 (2,836)**	0,386 (3,279)***	-0,244 (-0,781)	-0,235 (-0,789)
$\ln q_r$	-0,328 (-1,191)*	-0,334 (-1,361)*	0,347 (1,218)*	0,355 (1,243)*
$\ln q_y$	0,336 (1,589)*	0,338 (2,074)**	-0,144 (-0,867)	-0,162 (-0,886)
trend	0,209 (0,658)	0,226 (0,805)	0,315 (0,716)	0,349 (0,823)
$R^2$	0,872***	0,889***	0,682***	0,689***
$R^{-2}$	0,607	0,612	0,409	0,414
F	7,398***	7,418***	2,504***	2,511***
DW	2,769***	2,787***	2,648**	2,659
$\rho$	-0,253 (-0,708)	-0,282 (-0,814)	-0,212 (-0,734)	-0,234 (-0,756)

(1) The definition of independent variables is provided in section 7.7. The first step of the two-step full transform method was to estimate the model using the ordinary Least-squares method. The autoregressive parameter  $\rho$  was estimated and its values were not significant.

\*\*\*, \*\* and \* indicate significance at the 1; 5 and 10 percent levels. The numbers in parentheses are t-values.

Following the model expectations the coefficients of the lagged area of land cultivated ( $q_{L-1}$ ) by both farmers have opposite signs than expected in both equations.<sup>58</sup> The coefficient of rainfall variables ( $q_r$ ) also displays the opposite sign than expected in both equations (A) and (B) for large farmers showing diminution in the quantities. It can be stated that equation (B) has been the most appropriate in providing a good fit of wheat supply by the large farmers, while equation (A) has provided the expected fit of wheat supply by the small farmers.

The estimate of the own-price elasticity of wheat supply in the area of study was about 0,386 (Table 14). This has been compared to that reported on wheat supply in Nigeria of about 0,437 by Bond.<sup>59</sup> The own-price elasticity of wheat supply by the small farmers was about -0,244 (Table 14). Hence a change in the domestic producer price of wheat could reduce supply by the small farmers and will increase that of the large farmers, given other factors remain constant. Bond's estimate of the own-price elasticity of wheat supply was obtained by using a Nerlovian type of the model where crop yield was considered as a dependent variable rather than a total output. This approach was avoided by using a crop yield as an independent variable in this study for simplicity in the calculation.

These results confirm the theoretical proposition which states that farmers, if their resource endowments are satisfactory, would reallocate themselves at the margin in favor of the crops where the relative producer price increases. The only difference in the size of the response may be explained by the premium that farmers tend to place on food self-sufficiency.<sup>60</sup> This relates to large farmers only.

Despite data limitations, it is clear that wheat output and its own-price elasticity compete highly among large farmers producing wheat and maize in the area of study. The difference between the own-price elasticities of both crops has been enormous in the case of large farmers as compared to the small farmers producing the same crops.<sup>61</sup>

The inclusion of a trend variable in the wheat supply function was to represent it as a proxy variable in order to create change in the wheat productive capacity and

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58 This could be attributed to the perception and innovations by the farmers.

59 See e.g. Bond, 1983:56-83.

60 Comments by Tshibaka, 1986:38.

61 The political consideration of the small farmers was discussed in section 8.3.3, page 117.

technology over time. The direction of the relationships between wheat output and its own-producer price has been clear as it was in the case of maize output. However, a close observation of the results shows that wheat producer prices display a declining trend over time, suggesting a positive relationship between its output and own-producer price.<sup>62</sup>

#### 8.4.2 *Review*

Two equations were adjusted to test the data on wheat output supply by both large and small farmers investigated in the area of study. ....

In both equations (A) and (B) the fit was satisfactory. Equation (B) was the most appropriate in providing the expected results for the large farmers, while equation (A) has provided the expected regression results for the small farmers.<sup>63</sup>

There has been a great variation in the total area of wheat cultivated by the large farmers as compared to the previous cultivated areas. A consistency in the area cultivated by the small farmers was observed in wheat supply in the area. Although this variation exists in the total area cultivated by the large farmers, wheat supply depends mainly on the modern inputs, cultivated area, producer prices and the technology used. These elements made a great difference in wheat production between the two groups of farmers.

The own-price elasticity of wheat supply has shown that great incentives exist in the production of this crop by the large farmers. The analysis indicates that small farmers have difficulties in increasing their production. An increase in the prices would affect their production negatively, given other factors remain the same. On the other hand, the analysis suggests that small farmers have less political consideration in wheat production as compared to large farmers. As a result they tend to have a biased allocation of the resources in the agricultural production of this crop. Technological change occurs slowly in peasant small farmers and it is hardly noticeable. Shifting of cultivation continues to be the most prevalent method of production of this group of farmers.

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62 See appendix B<sub>2</sub>, page 196.

63 Small farmers wheat supply is lacking behind and cannot be a source of increased income as is the case of the large farmers.

The statistical characteristics for wheat production by the large farmers seem to be satisfactory as compared to the small farmers. As was the case with maize supply, wheat output by the small farmers cannot be a source of increased income.

## 8.5 *SORGHUM PRODUCTION : LARGE FARMERS*

This section discusses sorghum production by a group of large farmers investigated in the area of study. This study had to focus more on the analysis of large farmers because of a lack of data on individual small farmers. The producer price data used in this study for sorghum analysis is also severally limited.<sup>64</sup>

There appears to be a conflict between maize and sorghum output supply by both large and small farmers. Given that the producer prices for these two commodities are primarily determined by the domestic demand and supply schedules, the two types of parameters that need to be estimated are namely the own-price and cross-price elasticities of sorghum output. The own-price elasticity indicates the extent to which sorghum output is affected as a result of a 1 percent change in this crop's own-price. Whereas the cross-price elasticity gives the impact of a 1 percent change in a competing crop such as maize producer price on it's output.

The cross-elasticity indicates whether there may be a conflict between the two crops in the production. Because of data limitations, the analysis is not extended to an appraisal of the implications of crop conflicts in the production, farm income and employment in the agricultural sector as a whole. The analytical framework used originated from a rapidly growing list of agricultural studies and has been applied to this research.<sup>65</sup>

### 8.5.1 *Statistical results*

Two equations were adjusted to test the data on sorghum production by a group of large farmers investigated in the area of study. A nonlinear Cobb-Douglas function was used for this analysis.<sup>66</sup> According to the results of both equations (A) and (B), equation (B) has been the most appropriate by providing the expected results. The estimated regression coefficients of the explanatory variables have the expected signs

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64 See appendix B<sub>1</sub>, page 192.

65 See e.g. Tshibaka, 1986:21-40.

66 See Gallant and Goebel, 1976:961-967 and Harvey, 1981:182-202.

and they were statistically significant at the 1, 5 and 10 percent levels as indicated by the t-values in parentheses (see table 15).

**TABLE 15: Regression results for sorghum supply in the area of study, 1978-91.**

Independent variables (1)	Dependent variable : $\ln Q$ sorghum	
	Large farmers	
	Equation (A)	Equation (B)
Constant	-2,525	-2,574
$\ln q_{L-1}$	0,003 (0,074)	0,028 (0,184)
$\ln q_1$	0,328 (3,779)***	0,331 (3,784)***
$\ln q_f$	0,214 (2,118)**	0,222 (2,991)***
$\ln p_i$	0,306 (2,108)**	0,318 (3,243)***
$\ln q_r$	-0,395 (-1,433)*	-0,398 (-1,456)*
$\ln q_y$	0,384 (1,562)*	0,387 (1,614)*
trend	-0,177 (-0,443)	-0,217 (-0,488)
$R^2$	0,734***	0,737***
$R^{-2}$	0,506	0,509
F	3,277*	3,286*
DW	1,715	1,784*
$\rho$	-0,060 (-0,211)	-0,072 (-0,246)

(1) See the definition of variables in section 7.7.

\*\*\*, \*\* and \* indicate significance at the 1; 5 and 10 percent levels. The numbers in parentheses are t-values. The first step of the two-step full transform method was to estimate the model using the ordinary least-squares method. The autoregressive parameter  $\rho$  was estimated and the values were not significant.

The own-price elasticity of sorghum supply estimated from equation (B) was about 0,318. According to Bond,<sup>67</sup> Oyejide estimated the own-price elasticity of sorghum output in Nigeria at about 0,53. In the same manner, Bond estimated the own-price elasticity of sorghum supply in Sudan at about 0,27.

The analysis of the own-price elasticity provided in this study gives some useful indications of the impact of change in sorghum producer prices and its supply. The analysis suggests that a change in sorghum producer prices would significantly affect the sorghum output, other factors remaining the same.

The price intervention policy measures in the agricultural sector should be the main policy devices to be introduced and used by any government to create changes in the agricultural crop production and in the economy as a whole. Producer prices are great incentives to farmers in the production process. It could be stated that these policy instruments have been the most important policy measures which could determine changes in the crop output as a whole.

The tendency to rely on price policies to introduce changes in the economy has always been appealing to policymakers in most developing areas, including the area of study. The effectiveness of such price policies depends greatly on some complementary resource development policies. Both sets of policies should be considered simultaneously if a self-sustained growth of the farm and nonfarm sectors is to be achieved.

### 8.5.2 *Sorghum and maize output supply conflict analysis*

The analytical framework used in this section follows that of Bapna. Five price expectation models were tried by Bapna in his study of aggregate supply response of crops in India. Two of these prices were selected for the purposes of supply conflict analysis in this study. Firstly, it is assumed that the farmer expects the prices of the last cropping season to prevail in the current season; in this case the expected price could be expressed as provided in equation (36).

$$P_i = P_{t-1} \quad (36)$$

Secondly, the farmer assumes that a weighted average price for three years is also important. The weights in this case are 3,2 and 1. In this way the expected price could be computerised as given in equation (37).

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67 See e.g. Bond, 1983:50-96 for more comments.

$$p_2 = (3p_{t-1} + 2p_{t-2} + p_{t-3})/6 \quad (37)$$

where:  $p_2$  = the weighted price over the three years;

$3p_{t-1}$  = price of the third year;

$2p_{t-2}$  = price of the second year;

$p_{t-3}$  = price of the last year, and

$n = 6$ .

Both prices were divided by the total number of years to have a weighted average price for the past three years.

The estimates on the supply response were obtained by using the traditional method of using prices of the previous years which are taken as an underestimation of data on production.<sup>68</sup> The producer prices and the wage rates used in the analysis of sorghum in this study were trended using the consumer price index as deflator to avoid multicollinearity problems. However, the wage rate and the consumer price index data was also limited.

Maize data refer to the area of study as a whole and the distinction is made only on the peasant small farmers and commercial farmers. It is evident that peasant farmers and commercial farm owners in the area differ in their supply responsiveness to own-price changes and to crop substitution possibilities such as in the case of sorghum and maize supply. A small farmer can shift resources from maize to sorghum or rice production easier than a large farmer or commercial farmer could. For a small farmer, the cross-price elasticity of supply would be expected to be significantly different from zero, whereas that of large farmer would be zero.

Commercial farms are highly specialised in handling only one crop such as maize. In addition, the supply responsiveness to own-price change would be greater than that of the small farmer because the latter has more crop substitution possibilities. The extent of this bias in the regression results is difficult to determine.

Table 16 presents the regression results for the cross-elasticity of sorghum with respect to the maize producer price. In both sorghum equations (A) and (B) the fit is satisfactory. The regression coefficients of the explanatory variables have the expected signs and were statistically significant at the 1, 5 and 10 percent levels, as indicated by the t-ratios in parenthesis.

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68 Stated by Nerlove, 1958:87-111.

The estimated cross-elasticity of sorghum with respect to maize producer price was about -0,278. This suggests that there is a conflict between sorghum and maize supply in the area of study. In this way, one can infer that there are possibilities of a trade-off between the two crops in the area. A change in the relative domestic producer price of maize would affect significantly the production of sorghum. Practically, this conflict is slightly reduced by the number of maize producers and buyers rather by the number of sorghum producers and buyers. In other words, there is a greater number of maize producers and buyers as compared to grain sorghum producers and buyers in the area of study.

**TABLE 16: Regression results for sorghum cross-elasticity with respect to maize producer price in the area of study, 1978-91.**

Independent (2)	Dependent variable : $\ln Q$ sorghum variables	
	Equation (A)	Equation (B)
Constant	4,697	4,863
$\ln p_1$ sorghum	0,454 (2,468)***	0,000
$\ln p_1$ maize	-0,423 (-2,637)**	0,000
$\ln p_2$ sorghum	0,000	0,329 (3,358)***
$\ln p_2$ maize	0,000	-0,278 (3,837)***
$\ln$ wage	-0,018 (-0,452)	-0,238 (-1,549)*
trend	-0,314 (-0,436)	-0,349 (-0,576)
R <sup>2</sup>	0,873***	0,892***
R <sup>-2</sup>	0,543	0,572
F	3,589***	0,596***
DW	2,884***	2,891***
$\rho$	0,027 (0,206)	0,228 (0,423)

- (2)  $p_1$  = producer price lagged one year ( $p_{t-1}$ ),  $p_2$  = weighted average producer price for three years ( $3p_{t-1} + 2p_{t-2} + p_{t-3}/6$ ). The first step of the two-step full transform method was to estimate the model using the ordinary least-squares method. The autoregressive parameter  $\rho$  was estimated and the values were not significant. \*\*\*, \*\* and \* indicate significance at the 1; 5 and 10 percent levels. The numbers in parentheses are t-ratios.

The wage rate is also a critical determinant of the crop output. The cross-elasticity of sorghum with respect to the wage rate was about -0,238. This suggests that an upward pressure on the wage rate would have negative effects on the production of sorghum. The findings of the wage paid offers substantial evidence in the case of rural-urban labour migration which tends to reduce the supply of farm labour. This has an upward pressure on the wage rates and as a consequence there is a downwards pressure on the sorghum supply.

Although the estimates of the own-price and cross-price elasticities provided in this study may not be as accurate as it could be expected, they do help to assess the effects of the agricultural development policies analysed in this research.

### 8.5.3 *Review*

Two different functions were adjusted to analyse sorghum production by the large farmers selected in this study. In both equations (A) and (B) the fit was satisfactory. The results of the equation (B) are the most appropriate in providing the expected regression coefficients. The lack of data on small farmers in the area studied has made it impossible for this study to analyse sorghum production by this group of farmers.

The estimated own-price elasticity of sorghum supply was about 0,318. It shows that there is a great deal to invest in this crop because of incentives in terms of its producer price and marketing. In the analysis process, the study has assumed that sorghum production could be increased cautiously to avoid more investment in terms of processing and marketing facilities.

The statistical characteristics for all the regression coefficients of the explanatory variables explained that not less than 73 percent of the total variations in sorghum production were provided by these variables in the model. The coefficient of trend variables was not significant. The adjusted coefficient of determination was almost 54 and 57 percent respectively.

The analysis of sorghum and maize supply conflicts in this study was based upon the last cropping season and weighted average prices. This process has lead to the estimation of the cross-price elasticity of sorghum with respect to the maize producer price. The cross-price elasticity estimated was about -0,278; which suggests that there is a conflict in the production of the two crops in the area studied. The estimates of the own-price and cross-price elasticities provided in the

study may not be as accurate as it could be, but they do help to assess the extent of effects of the agricultural development policy measures analysed.

## 8.6 CONCLUSION

Generally, it can be stated that a nonlinear Cobb-Douglas model used in this study satisfactorily explained the variations in the supply of both maize, wheat and sorghum by the large and small farmers investigated in the area of study. Two different equations were adjusted to test the data on the supply of these crops. The statistical characteristics for all the regression coefficients were satisfactory. The estimated regression coefficients for both groups of farmers were statistically significant at the 1, 5 and 10 percent levels as indicated by the t-ratios. The adjusted coefficient of determination ( $R^2$ ) for both maize, wheat and sorghum was 0,57; 0,61 and 0,73 respectively; indicating that the adjustment in the supply of both crops has been good during the period of the study.

The variables used in the model have explained the variations in the supply of maize, wheat and sorghum. This is indicated by the magnitude of the coefficient of determination for both crops analysed of 86, 87 and 73 percent of output by the large farmers; 79 and 74 percent of output by the small farmers. The results of the model indicate that an increase in the use of fertiliser by the large and small farmers of 10 percent for example would result in an increase of the supply. In this way agricultural output would grow and will affect the growth of the GDP.

Available evidence from the supply functions of both crops by the small farmers indicated that in aggregate, there is a limited use of modern inputs by this group of farmers in the area of study. Technological change also occurs slowly in small farmer groups and it is hardly noticeable. Irregular cultivation has been one of the limiting factors in the productivity of small farmers.

The estimated own-price elasticities of supply of both crops indicates that there are incentives in the production of maize, wheat and sorghum by large farmers in the area of study. The analysis of these supply elasticities suggested that a change in the producer prices of both crops would have a significant impact on the supply by the large farmers. Small farmers, the chief producers of all the food in most rural areas have much less political consideration as compared to the large farmers. This has resulted in a biased allocation of resources by the small farmers.

Price intervention policy measures should be the main policy devices to be used by the government to effect changes in the agricultural production and in the economy as a whole. It could be stated that these instruments would be the most important determinants of the changes in the crop supply. This is because they determine not only the intersectoral movements of the resources, but they also affect the availability of other resources such as foreign exchange earnings.

The estimated cross-price elasticity of sorghum with respect to the maize producer price was about -0,278 suggesting that there is a conflict between maize and sorghum supply in the area of study. Since sorghum is a maize substitute, one can infer that there is a trade-off between the two crops. Hence, a change in the domestic producer price of maize would significantly affect the production of sorghum in the area of study.

## **CHAPTER NINE**

### **SUMMARY AND RECOMMENDATIONS**

#### **9.1 INTRODUCTION**

The purpose of this chapter, which is divided into three main sections, is to present the summary and recommendations derived from this research. The first section gives an overview of the problem/need for the study, objectives, methodology and the review of the results of the model. The second section presents the implications of the agricultural development and policy for economic growth and development. Finally, the third section provides a useful discussion on limitations, suggestions and recommendations of the research.

##### **9.1.1 The study problem**

Basically, this research deals with the problem of how the agricultural sector could be directed to influence economic growth for accelerated development in the area of study, and in which the aspirations of every community member could be achieved towards reaching a better quality of life and integrated into meaningful socio-economic changes.<sup>69</sup>

Agricultural development has been always a complex process, in order to assess the problem of the study, a theoretical analysis of agricultural development, agricultural practices, productivity and land tenure and lack of growth in the economy were discussed to explain the need for the study.

##### **9.1.2 Objective of the study**

The main objective of this research has been to examine the agricultural development strategy, policy and implementation process leading to poverty eradication in the area of study. The seven specific objectives analysed are:<sup>70</sup>

1. the analysis of certain popular opinions about the importance of the agricultural development process;

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69 See section 1.1.1, page 1.

70 Discussed in section 1.1.1, page 1.

2. examination of the implementation of an agricultural development policy with the political commitment to reduce poverty;
3. examination and analysis of the role of agriculture for economic growth in the area of study up to 1991;
4. investigation into the obstacles and opportunities of the agricultural development and its redirection for economic growth and development in the area of study;
5. to focus on the comparison of the appropriateness of the agricultural growth process with the present theory of development, and
6. the development of an econometric model for analysis of some specific objectives of the research.<sup>71</sup>

### 9.1.3 Methodology

Any kind of model analysing the economic sector should be based on some useful theories of economic growth and development. The instruments of the analysis used in this study include both a review of the relevant literature from different journals, books and some existing studies conducted in the field of the research. Empirical data collection by questionnaire and personal interview form the other part of the methodology.

An econometric/mathematical model of the rural households was developed to stimulate agricultural development in the area of study. The model aggregates enterprise levels of agricultural activities predicted for the rural households.

A Cobb-Douglas function describing a microeconomic nonlinear model of farmer's decision-making with respect to resource allocation and productivity was used.<sup>72</sup> The major role of the model was to simulate land allocation and productivity of the crops analysed and other farm resources on the basis of their opportunity costs in alternative uses, and on the basis of the relative productivity of the farmer.

Statistical instruments such as regression analysis, coefficient of determination ( $R^2$ ), the adjusted coefficient of determination ( $R^{-2}$ ), statistics F and Durbin Watson (WD)

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71 Provided in section 1.1.2, page 2.

72 See e.g. section 2.3.3, 2.9 and 7.9.3.

were the primary statistical tools used to provide an empirical analysis of the economic growth through the agricultural sector analysis in this study.

#### **9.1.4 Review of the results of the research**

This section presents the summary of main conclusions of each chapter developed in this study.

In *chapter 2* the popular opinions about the importance of agricultural development process were discussed and the main findings were:

1. a prosperous agricultural sector would contribute to economic growth and development of both rural and urban areas, and
2. growth in the agricultural sector can bring about increases in rural income which is a major potential market for consumer goods and will generate more employment facilities especially in the rural areas.<sup>73</sup>

In *chapter 3* the analysis of the role of agriculture in the study area was provided and the main conclusions were:

1. the role of agriculture in the former Bophuthatswana was not significant for its economic growth and development;
2. the contribution of the agricultural sector was almost 3%, as compared to mining 60% and manufacturing 8%;<sup>74</sup>
3. generally, the agricultural output was not enough to satisfy the domestic demand for agricultural products, and<sup>75</sup>
4. the domestic demand for food was supplemented by significant quantities from the RSA.

In *chapter 4* the implementation of agricultural development policy was discussed and the main findings were:

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73 Described in 1.7, page 11.

74 Discussed in table 3, page 43.

75 Described in section 3.6, page 57.

1. agricultural development policy is vital because it creates changes in the agricultural sector, more specially in the production process, distribution and utilisation of the output;
2. the main focus of an agricultural development policy should be to determine a positive contribution of the agricultural sector to economic growth;
3. an understanding of the existing agricultural conditions is vital to make the necessary adjustments to agricultural policy at both local and state levels, and
4. the major constraints to agricultural development policy in the former Bophuthatswana has been it's effective implementation by both farmers and in rural areas.<sup>76</sup>

In *chapter 5* the main findings could be summarised as follows:

1. an economic activity is socially profitable when its domestic resource cost (DRC) is less than the shadow accounting price of the foreign exchanges;
2. a principal factor limiting resources in the agricultural sector for it's growth and development is the population growth; to avoid population pressure on the agricultural sector a control of population growth is necessary, and
3. training of the local people has been the most effective way to promote agricultural productivity; an investment in the people through training is vital to enhance the productivity capacity of the individuals and the society as a whole.<sup>77</sup>

In *chapter 6* the main conclusions were:

1. the data was collected by means of a questionnaire known as "The Actual Needs";
2. the sample population was defined as all the farmers living in the area of study; the sample unit was a household, and

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76 See section 4.10, page 72.

77 See section 5.5, page 85.

3. a probability sampling procedure was used to generalise the results of the survey for all the farmers in the area.

In *chapter 7* an econometric model for analysis of some specific objectives was developed. The development and formulation of such a model was also provided in chapters 2 and 8. The main results were:

1. the assumption about expected producer prices, expected input prices, weather conditions and technology as the main determinants of the output response in agriculture has been considered in the model formulation;<sup>78</sup>
2. the most important variables included in the model were capital, land, labour, producer price, technology, rainfall, yield per hectare and the trend variable, and
3. the purpose of the model was to simulate land allocation and productivity of the crops analysed and other farm resources on the basis of their opportunity costs in alternative uses.

#### 9.1.5 *Review of the results of the model*

The role of agriculture for accelerated development was investigated in this study from the different sources of information, namely a review of relevant literature on both the commercial and subsistence agricultural sector.<sup>79</sup>

The models developed follow a viewpoint which emphasises the role of agriculture for economic growth and development in the area of study. The provision of the models has shown how the agricultural sector will have its role well defined in contributing to economic growth and development in the area of study.<sup>80</sup>

A nonlinear Cobb-Douglas model used in the analysis of data in this research satisfactorily explained the variations in the supply of maize, wheat and sorghum by the large farmers.<sup>81</sup> The statistical characteristics for all the regression coefficients were satisfactory in the case of large farmers as compared to the small farmers

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78 See section 7.10, page 109.

79 Described in 1.7, page 11.

80 See e.g. the analysis of individual crops in 8.3.1; 8.4.1 and 8.5.1.

81 See results given in tables 13, 14, 15 and 16.

investigated in the area of study. The estimated regression coefficients for large farmers were statistically significant at the 1, 5 and 10 percent levels compared to the small farmers.

The estimated own-price elasticities of supply for both crops indicated that there are incentives in the production of maize, wheat and sorghum by large farmers than by the small farmers in the area of study. The analysis suggested that a change in the producer prices would have a more significant impact on the supply of both crops by the large farmers in relation to the small farmers.<sup>82</sup>

Available evidence from the supply functions of both crops suggested that in aggregate, there is a limited use of modern inputs by the small farmers in the area of study. Innovations are slow and shifting cultivation has been the most prevalent method of their production system. Although supply by the small farmers is not significant, they are targeted to increase their income.

The results of the models indicated that in response to agricultural policy change, large farmers could change to a certain extent their land utilisation, crop production, input demand and income patterns over time. The impact on areas allocated to the various crops are the primary effect of changing agricultural practices<sup>83</sup> in the subsistence agricultural sector. The impact on other variables of the model could be determined as a consequence of changes in the policy and allocation decisions among alternative enterprises or farmers.

Generally, the results of the models suggest that there is a considerable possibility for agricultural growth to increase economic development of the area of study, more specially with the production of maize, wheat and sorghum by the large farmers.

Although the model was applied to the agricultural conditions prevailing in Madikwe and Taung districts, the results were generated for the area of study as a whole.<sup>84</sup>

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82 See results given in tables 13, 14, 15 and 16.

83 Described in 1.3.2, page 3.

84 Described in 6.4 of probability sampling.

## 9.2 *IMPLICATIONS FOR AGRICULTURAL DEVELOPMENT AND POLICY*

### 9.2.1 *Implications for agricultural development*

One phenomenon that occurs coincidentally with the modernisation of traditional agriculture is a change in the consumption of farm inputs, particularly an increase in purchased inputs. Given the actual conditions of basic yield levels, the demand for and use of fertiliser in the country should be increased to accelerate changes in the agricultural production. The introduction of accepted levels of mechanisation<sup>85</sup> could also be a means to raise the regional demand for fertiliser. This implies that technological changes would have a significant impact on changing the structure of farm demand for manufactured inputs. The increased demand may also be an incentive for the development of a domestic fertiliser industry, which in turn would represent savings in foreign exchange used to import fertiliser.

The small farmers could use at least up to 50 percent of the total quantity of fertiliser because of a more intensive use of land. Large farmers, however, have more extensive natural pasture areas than the small farmers. Crop production requires more inputs than beef production. Improvements in technology<sup>86</sup> tend to affect the patterns of employment and input utilisation on large farms more because they will have greater potential to expand the use of various modern inputs. Therefore, if input supply is limited, resources will be shifted from one group to the other, with large farms buying up a large proportion of the resources. Hence, income of the large farmers increases more than that of the small farmers due to diversity in technological capacity.

The implications for agricultural development are also found in the distribution of income<sup>87</sup> among the groups of farmers in the area of study.

Clearly there is a tendency for the income gap between farm size groups to increase over time. The introduction of higher levels and variety mechanical technology would result in higher projected growth rates of the net output in agriculture for the large farms as compared to the small farms. Consequently, the share of large farms in both total and net regional output would increase more than that of the small

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85 Discussed in section 1.3.4, page 4.

86 See section 1.4.2, page 8.

87 See section 2.2.2.4, page 16.

farms. Thus, large farms would tend to buy off resources and increase their farm sizes much faster than the small farmers, since they are better off in experiencing higher increases in their income.

Change in land use has shown that there is a relative scarcity and different technology choices among farm size groups. Land productivity is higher in the small farms while labour productivity is higher in the large farms. For both types of technology used in production, the agricultural land productivity increases more at the large farms than the small. Therefore, differences in factor productivity<sup>88</sup> among farm sizes are possibly due to the differences in technology of production.

### 9.2.2 *Implications for agricultural policy*

Agricultural development policy is essentially an instrument that creates changes in the agricultural production process, distribution and utilisation of the inputs and outputs. The correct role of the agricultural sector to stimulate economic growth and development in the wider regional area could be determined by its positive contribution to economic growth and development of the area being studied.

To ensure an optimal combination from the agricultural sector, special policy measures and strategies should be determined, formulated and implemented. These instruments will determine the role of the public sector and the incentives granted to the agricultural sector. The agricultural policy<sup>89</sup> formulation should take into account the various aspects and conditions prevailing in the country to ensure an effective policy mix to optimise the contribution of the agricultural sector for economic growth and the distribution of benefits. The major constraints to agricultural policy has always been its practical implementation.<sup>90</sup>

The agricultural policy has been a more important instrument<sup>91</sup> to gain a perspective on the impact of agricultural investment to stimulate agricultural growth for economic development. This tool has the potential to enforce the principle of costs and benefits on commodities from the agricultural sector. A better understanding of the Batswana household economics is vital to make the necessary adjustments to the

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88 See section 1.3.5, page 5.

89 Provided in Table 11, page 74.

90 Provided in Table 11, page 74.

91 Discussed in 4.6.2, page 65.

formulation and implementation of the agricultural policy at both local and state levels. Agriculture has been the greatest resource and the most important economic activity of many rural communities. Therefore, it is of vital importance that this sector should be put on a sound footing by creating opportunities for food, cash-crop and livestock production through effective implementation of the agricultural development policy.

### 9.3 *LIMITATIONS OF THE STUDY*

Different sources of information were used in order to reach the objectives of this research. However, it should be stressed that the data restricted the performance of the model because it include the following variables:

The price data which include producer price and crop own-prices were limited. Individual data on crop output supply by both large and small farmers investigated in the area of study were also limited. Although this research was based on the primary data, it appears that annual data on crop production used in this study were also limited. These include data on technology, labour, fuel and depreciation which was not available for utilisation in the model.<sup>92</sup>

Another basic difficulty has been mainly the limitations of available data on production costs and returns by both farm size groups to allow for differences among farmers with respect to production decisions and the choice of technology. This is a special case where the model would include more classes, the basic data by size group would be more essential for model performance.

It should be stated that research on the reaction of both large and small farmers to government agricultural policy measures in the former Bophuthatswana was limited. There is also a limitation in crop supply response research conducted in the area. The findings provided in this study were basically the results of the model performance as formulated by this research.<sup>93</sup>

The Cobb-Douglas model has some inconveniences namely the impossibility in describing phenomena related to the marginal productivities whether they are increasing, decreasing or constant. One important fact about the use of the Cobb-

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92 See e.g. section 7.8; equation (30), page 104.

93 See e.g. section 7.8; equation (30), page 104.

Douglas model is that it is capable of providing an impact analysis of the agricultural sector for economic growth and development of the country.<sup>94</sup>

#### 9.4 SUGGESTIONS

It is generally postulated that expected crop producer prices, expected input prices, weather conditions and the technology of production are the main determinants of the output in the agricultural sector. This general formulation is the basis for suggestions of this study which are mainly in line with the agricultural policy instruments.

In order to promote agricultural growth in the area of study, this study suggests that price intervention<sup>95</sup> policy measures should be used as the main policy devices to affect changes in the agricultural production and in the economy as a whole. Because these policy tools determine not only the intrasectoral and intersectoral movements of the resources, but they also affect the availability of other resources such as foreign exchange earnings.

The tendency to rely mostly on price policies to introduce changes in the economy in general and particularly in agricultural production has always been preferred by policymakers in many developing countries including the former Bophuthatswana.<sup>96</sup> However, it is suggested that the effectiveness of such price policies should depend more on some complementary resource development policies. Both sets of policies should be considered simultaneously if self-sustained agricultural growth of the farm and non-farm sectors is to be achieved.

Agricultural development research has been the key factor to be utilised in obtaining significant improvements in any established agricultural activity. This study suggests that an efficient agricultural development research effort for increasing agricultural productivity in the presence of increased population and diminishing arable land, needs to be undertaken. To promote agricultural growth in the country an appropriate and effective research team should be formed. The selection of such a team should be based on the agricultural activities pursued by the local farmers. The experts in this team must be able to understand the aspirations and objectives of the farmers and study well proposed solutions by the farmers to their problems

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94 Described in 7.9.3.2, page 107.

95 Discussed in 7.7, page 102.

96 See section 7.6, page 102.

before any decisions are taken. From the farmers' viewpoints, they then jointly draw up and refine the farming research needs in that particular area.

This study suggests that applied agricultural research<sup>97</sup> should be conducted in key areas such as variety trials, planting processes, soil fertility maintenance, mixed cropping association on the farmers' land at the district levels.

## **9.5 RECOMMENDATIONS FOR FUTURE RESEARCH**

This section summarises the most important areas for future studies as recommended by this research.

### **9.5.1 Resource allocation between farm size groups**

Further research should be concentrated on the ways and manners of dealing with farm size groups. Land structure<sup>98</sup> changes over time and the transfer of land from one group of farmers to another. Such models should allow for change in the structure including some mechanism to account for resource transfer among farm size groups. Also, related to land issues, the problem of incorporating new land to increase the agricultural production per farm size group should also be dealt with in the model.

### **9.5.2 Improvements in the model**

Some basic improvements in the model may include the use of farm resources such as fertiliser, credit and labour or farm machinery capacities by season, and the incorporation of financial activities. These variables could be used to represent farmers' ability to change the agricultural activities from one activity to another. Improvements in the model specification would reduce the constraints in projecting production patterns and would also improve the performance of the model.

### **9.5.3 Income distribution**

The introduction of new methods of production<sup>99</sup> would have an impact on the income of the farmers. More important, however, is that a detailed treatment of the

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97 Discussed in 2.5, page 30.

98 See section 2.2.3.4, page 21.

99 Discussed in section 1.4.2, page 8.

various sources of income at the farm household levels by farm size groups should be provided. This would require the inclusion of specific income activities in the model to account for the different alternatives and possibilities open to farmers in the country.

#### **9.5.4 *Relationship of the model to other sector models***

Due to the flexibility of the model and its computer programme facilities, it could be used as a separate model or be utilised in interaction with a larger sector model. An important function of the model would be to serve as a decision-making process to determine endogenous variables in the allocation of land and other farm resources to promote agricultural production, based on the opportunity cost of the resources and also on the relative profitability of the various farm enterprises.

Future modelling efforts could include other components of the agricultural sector models and model of economic growth and development. The model developed in this study could be used as an economic tool representing policy instruments on the one hand, and on the other hand, it represents farmers' decisions with respect to agricultural production.

#### **9.5.5 *Improvements of data base***

Finally, this study made use of farm data collected through a questionnaire<sup>100</sup> prepared for the same purpose and also some secondary data obtained from the annual reports and various documents from the different departments. In view of the difficulties related to the collection of agricultural data, this research recommends that improvements in data collection and consistency checks on secondary data should receive greater attention of the government and non-government agencies responsible for data collection, analysis and interpretation.

Finally, the conclusions and recommendations derived from this study on model applications are subjected to the limitations of the information and the appropriateness of the model assumptions and specifications as it has been experienced by this research.

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100 See appendix A<sub>3</sub>, page 176.

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***APPENDIX A<sub>1</sub>***

***Simple cultural model calculation***

Appendix A<sub>1</sub> :

Simple cultural model calculations.

Average income ( $y$ ) and the level of literacy ( $x_i$ ) of a sample of 50 small farmers investigated in ten districts of Bophuthatswana, 1991.

Observations	$Y_i$	$X_i$	$Y_i = y - y$	$X_i = x - x$	$xy$	$y^2$	$x^2$	$y$	$\epsilon_i$	$\epsilon_i^2$
1 (6)	40	80	-16,2	-119	1927,8	262,44	14161	39,66	0,34	0,1156
2 (6)	45	75	-11,2	-124	1388,8	125,44	15376	46,44	-1,44	2,0736
3 (5)	47	85	-9,2	-114	1048,8	84,64	12996	50,22	-3,22	10,3684
4 (5)	50	100	-6,2	-99	613,8	38,44	9801	45,00	5,00	25,0000
5 (4)	55	150	-1,2	-49	58,8	1,44	2401	51,78	3,22	10,3684
6 (4)	60	200	3,8	1	3,8	14,44	1	63,56	-3,56	12,6736
7 (5)	60	250	3,8	51	193,8	14,44	2601	60,34	-0,34	0,1156
8 (5)	65	300	8,8	101	888,8	77,44	10201	63,60	1,40	1,9600
9 (6)	70	350	13,8	151	2083,8	190,44	22801	73,86	-3,86	14,8996
10 (4)	70	400	13,8	201	2773,8	190,44	40401	67,56	2,46	6,0516
Total (50)	562	1990	0	0	10982,0	999,63	130740	562,02	0	83,6264

$$\begin{aligned} \text{A)} \quad \bar{y} &= 56,2 \\ \bar{x} &= 199 \end{aligned}$$

$$\text{B)} \quad t = \frac{x_1 - x_2}{\sqrt{\frac{1}{n_1} + \frac{1}{n_2} - 2}} = \frac{-33,655}{(-5,801)} \quad (38)$$

$$\text{C)} \quad \hat{\beta} = \frac{\sum x_i y_i}{\sum x_i^2} = 0,0840 \quad (39)$$

$$\text{D)} \quad \hat{\alpha} = \bar{y} - \hat{\beta} \bar{x} = 39,484 \quad (65)$$

$$\text{E)} \quad R^2 = \frac{\text{Corrected SP (XY)}}{\sqrt{\text{Corrected SSX} \cdot \text{Corrected SSY}}} \quad (40)$$

$$R^2 = 0,784$$

$$\text{F)} \quad \hat{e}_i = Y_i - \hat{Y}_i \quad (41)$$

$$\frac{\sum \hat{e}_i^2}{n-2} = \frac{1}{n-2} \left[ \sum y_i^2 - \beta \sum x_i y_i \right]$$

$$\text{G)} \quad Y_i = \alpha + \beta x_i + e_i \quad (\text{Adjusted function}) \quad (42)$$

$$\text{or } Y_i = 39,484 + 0,0840 x_i$$

$$e_i = 0$$

***APPENDIX A<sub>2</sub>***

***The questionnaire***

**APPENDIX A<sub>2</sub> - THE ACTUAL NEEDS SURVEY**

ENUMERATOR: \_\_\_\_\_

HEAD OF HOUSE : \_\_\_\_\_

PROJECT : \_\_\_\_\_

QUESTIONNAIRE NO.: \_\_\_\_\_

DATE : \_\_\_\_\_

- A. DEMOGRAPHIC DESCRIPTION** CARD NO. 

0	1
---	---

 (1-2)
- A1. Tribal Authority of area: \_\_\_\_\_ 

--

 (3)
- A2. Name of the village: \_\_\_\_\_ 

--

 (4)
- A3. Sex of head of house: 

1. Male	2. Female
---------	-----------

--

 (5)
- A4. How long has head of house been here? \_\_\_\_\_ years 

--	--

 (6-7)
- A5. Residential status of head of house? 

--

 (8)
- |                  |                  |                 |
|------------------|------------------|-----------------|
| 1. Home          | 2. Daily visit   | 3. Weekly visit |
| 4. Monthly visit | 5. Away employed |                 |
- A6. Estimated age of head of house: \_\_\_\_\_ years 

--	--

 (9-10)
- A7. (a) How many years did head of house attend school? 

--

--

 (11)
- A7. (b) What standard of education did he achieve? 

--

--

 (12)
- A8. Is head of house employed at present? 

1. Yes	2. No
--------	-------

--

 (13)
- If "yes", give monthly income: R \_\_\_\_\_ 

--	--	--	--

 (14-17)

- A9. Has head learned any skills? (i.e. welding, teaching etc.) 

1. Yes	2. No
--------	-------

 (18)
- If yes, specify: \_\_\_\_\_ 







 (19-20)
- A10. Is head married? 

1. Yes	2. No
--------	-------

 (21)
- A11. Estimated age of wife: \_\_\_\_\_ years 







 (22-23)
- A12. (a) How many years did head's wife attend school? 











 (24-25)
- (b) What standard of education did she achieve? 











 (26-27)
- A13. Is wife employed at present? 

1. Yes	2. No
--------	-------

 (28)
- If "yes", give monthly income: R \_\_\_\_\_ 















 (29-32)
- A14. Has wife learned any skills (sewing, nursing, teaching etc.)? 

1. Yes	2. No
--------	-------

 (33)
- If yes, specify: \_\_\_\_\_ 







 (34-35)
- A15. Does the head of house have any arable land? 

1. Yes	2. No
--------	-------

 (36)
- If "yes", how many hectares: \_\_\_\_\_ 







 (37-38)
- If "no", why not: \_\_\_\_\_
- A16. Does the household have a vegetable garden? 

1. Yes	2. No
--------	-------

 (39)
- A17. If "yes", is it a:
1. Household plot 







 (40)
2. Community garden 







 (41)

A18. The person interviewed is the:

1. Head	2. Wife	3. Son	4. Daughter	5. Brother
6. Sister	7. Father	8. Master	9. Other	

	(42)
--	------

A19. Age of person interviewed: \_\_\_\_\_ years

		(43-44)
--	--	---------

**B. SOCIO-ECONOMIC ASSESSMENT**

B1. Where do you buy your household supplies (e.g. food, clothing, etc)?

How far is it from your house?

Place	Kms													
1. _____	1. _____	<table border="1" style="border-collapse: collapse;"> <tr><td style="width: 40px; height: 30px;"></td><td style="width: 40px; height: 30px;"></td><td style="width: 40px; height: 30px;"></td></tr> <tr><td style="width: 40px; height: 30px;"></td><td style="width: 40px; height: 30px;"></td><td style="width: 40px; height: 30px;"></td></tr> <tr><td style="width: 40px; height: 30px;"></td><td style="width: 40px; height: 30px;"></td><td style="width: 40px; height: 30px;"></td></tr> <tr><td style="width: 40px; height: 30px;"></td><td style="width: 40px; height: 30px;"></td><td style="width: 40px; height: 30px;"></td></tr> </table>												
2. _____	2. _____	(48-50)												
3. _____	3. _____	(51-53)												
4. _____	4. _____	(54-56)												

B2. Indicate below how do you get your water. (X)

1. A tap inside the house.


--

(57)

2. From a tank in the yard.

--

(58)

- 3. Fetch from a spring.
- 4. Spring is piped to village.
- 5. From the dam.
- 6. Dam water is piped to village.
- 7. From a river.
- 8. River water is piped to village.
- 9. Other, specify.


 (59)

B3. Is the water source clean?

1.
2.

 (60)

B4. How far is the water source from the house (km)? \_\_\_\_\_

 (61)

B5. Is the water supply sufficient or not?

1. Sufficient	2. Insufficient
---------------	-----------------

 (62)

B6. Cooking facilities used?

1. Open fire	2. Primus stove	3. Coal stove
4. Electric	5. Gas stove	6. Wood stove

 (63)

B7. Type of fuel used?

1. Wood	2. Coal	3. Gas	4. Dung	5. Paraffin
6. Electricity				

 (64)

Cost per month: R \_\_\_\_\_

--	--	--

(65-67)

B8. From where do you obtain wood?

1. Forest	2. Veld	3. Woodlot	4. Shop
5. Do not use wood		6. Wood unobtainable	
7. Other specific			

	(68)
--	------

B9. Distance to wood supply? To be estimated (km): \_\_\_\_\_

		(69-70)
--	--	---------

B10. Housing details.

1. Owned	2. Rented
----------	-----------

	(71)
--	------

CARD NO. 

0	2
---	---

 (1-2)

B11. What type of house is it?

1. Traditional	1.
2. Rondavel	2.
3. Other, specify _____	

	(3)
	(4)

4. How many rooms? \_\_\_\_\_

B12. Type of toilet used.

1. Pit	2. Bucket	3. None
--------	-----------	---------

	(5)
--	-----

B13. If water and housing could be provided, what amount would you be prepared to pay for?

Water R/month: \_\_\_\_\_

			(6-8)
			(9-11)

Housing R/month: \_\_\_\_\_

B14. What group do you belong to? (women's groups, church groups, farmers groups, savings class)

Name of ground		Function of group	
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	

	(12)
	(13)
	(14)
	(15)
	(16)

B15. Name of the most important group?

1. \_\_\_\_\_

B16. Name of projects in area, if any:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

	(17)
	(18)
	(19)
	(20)
	(21)

B17. Which projects your community was involved in the past?

Project names	Successful	Unsuccessful
1.		
2.		
3.		

	(22)
	(23)
	(24)

B18. Reasons why the project was successful or unsuccessful:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

	(25)
	(26)
	(27)
	(28)

B19. Available skills in area. (Enumerator to facilitate):

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_

	(29)
	(30)
	(31)
	(32)
	(33)
	(34)

### C. FELT NEEDS

C1. What type of projects do you feel are needed in your area (village)?

Project names:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

	(35)
	(36)
	(37)
	(38)

C2. What kind of jobs need to be created in your area?

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

	(39)
	(40)
	(41)
	(42)
	(43)

C3. What do you feel the Community's major needs are?

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

	(44)
	(45)
	(46)
	(47)
	(48)

C4. What do you need to improve your crop production?

Needs		Reason for needs	
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	

	(49)
	(50)
	(51)
	(52)
	(53)

C5. What do you need to improve your livestock production?

Needs		Reason for needs	
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	

	(54)
	(55)
	(56)
	(57)
	(58)

C6. State what summer crops you grow and area planted. Specify whether the crop is mixed with another crop and what types of crops are mixed.

Type of crop	Is the crop 1. mixed 2. unmixed	If mixed, what crop is it with	Ha planted
1.			
2.			
3.			
4.			
5.			
6.			
Total area planted			

		(59-60)
		(61-62)
		(63-64)
		(65-66)
		(67-68)
		(69-70)
		(71-72)

CARD NO.

0	3
---	---

(1-2)

C7. State what winter crops you grow? Give area planted and specify if the crop is mixed with another crop.

Type of crop	1. mixed 2. unmixed	If mixed, what crop is it with	Ha planted
1.			
2.			
3.			
4.			
5.			
6.			
Total area planted			


(3-4)

(5-6)

(7-8)

(9-10)

(11-12)

(13-14)

(15-16)

C8. (a) Who ploughs your lands?

1. Self
2. Neighbour
3. Government
4. Tribal Authority
5. Contractor
6. Other, specify \_\_\_\_\_



(17)

(18)

(19)

(b) How is the land ploughed?

1. Oxen
2. Tractor
3. Other, specify \_\_\_\_\_



(20)

(21)

C9. Are you interested in having your own Oxen or Tractor?

1. Yes	2. No
--------	-------

(22)

C10. If yes, how much money would you be able to pay for?

(a) Oxen / month: R \_\_\_\_\_


(23-24)

(b) Tractor / month: R \_\_\_\_\_

(25-26)

C11. How many of the following types of livestock your household do have?

- 1. Cattle \_\_\_\_\_ head
- 2. Sheep \_\_\_\_\_ head
- 3. Goats \_\_\_\_\_ head
- 4. Horses \_\_\_\_\_ head
- 5. Donkeys \_\_\_\_\_ head
- 6. Pigs \_\_\_\_\_ head
- 7. Poultry (chickens, ducks, etc.) \_\_\_\_\_ head
- 8. Other, specify \_\_\_\_\_ head


(27-29)

(30-32)

(33-35)

(36-38)

(39-41)

(42-44)

(45-47)

(48-50)

**D. GENERAL**

D1. Do you buy all your food  
Most of it  
Half of requirements  
Only some

100%
80%
50%
25%

(51)

CARD NO. 

0	4
---	---

 (1-2)

D2. Approximately how much income is derived from:

(a) Agriculture per year? R \_\_\_\_\_

(b) Livestock per year? R \_\_\_\_\_


(3-6)

(7-10)

D3. What is your household income per month from:-

1. Wages R \_\_\_\_\_

2. Pension R \_\_\_\_\_

3. Remittance R \_\_\_\_\_

4. Own R \_\_\_\_\_

5. Other (specify) R \_\_\_\_\_


(11-14)

(15-18)

(19-22)

(23-26)

(27-30)

D4. What do you think people should do in order to be self supporting and independent?

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_


(31)

(32)

(33)

(34)

*APPENDIX A<sub>3</sub>*

*The results of the surveys*

APPENDIX A<sub>3</sub>: The results of the surveys

QUESTIONNAIRES	RESULTS
A <sub>1</sub> N of tribal authorities.....	17
A <sub>2</sub> N of villages .....	12
A <sub>3</sub> Sex of head of the house:	
Male.....	96
Female .....	181
A <sub>4</sub> Average stay in the village.....	35+
A <sub>5</sub> Residential states of head of the house:	
1. ....	37
2. ....	15
3. ....	49
4. ....	78
5. ....	98
A <sub>6</sub> Estimated average age of head of house .....	45+
A <sub>7</sub> (a) Average N of years at school.....	10
(b) Average standard achieved.....	8
A <sub>8</sub> Head of house employment record	
1. Employed.....	52
2. Not employed .....	225
3. Average income per month .....	R50
A <sub>9</sub> Skills learned by head of house	
1. ....	78
2. ....	199
A <sub>10</sub> Is the head married?	
Yes .....	134
No .....	42
Divorced.....	101

A <sub>11</sub>	Estimated average age of the wives.....	36+
A <sub>12</sub>	(a) Average years of school attended by wives.....	10
	(b) Average standard passed .....	9
A <sub>13</sub>	Employment record	
	1. ....	28
	2. ....	249
A <sub>14</sub>	Skills learned by wives	
	1. Have skills .....	114
	2. Have not.....	163
A <sub>15</sub>	If the head has any arable land	
	1. Yes .....	88
	2. No .....	189
	Average hectares possessed .....	1ha
A <sub>16</sub>	1. Have vegetable gardens .....	156
	2. Have not.....	121
A <sub>17</sub>	1. Household plots .....	99
	2. Community plots.....	142
	3. Have both household and community plots .....	36
A <sub>18</sub>	The person interviewed:	
	1. Mostly the wife .....	179
	2. Son or daughter.....	51
	3. Head .....	47
B <sub>1</sub>	Where do you buy your household supplies?	
	Rustenburg .....	157
	Vryburg .....	76
	Taung .....	44

B <sub>2</sub>	How do you get your water?	
	1. From public tap .....	148
	2. From borehole.....	83
	3. From a tank in the yard .....	32
	4. From a spring.....	14
B <sub>3</sub>	Generally the water is clean .....	257
	Generally the water is not clean.....	20
B <sub>4</sub>	How far is the water source from the house?.....	
	1. Quite far .....	147
	2. Not so far.....	66
	3. Very near .....	64
B <sub>5</sub>	Is the water sufficient or not?	
	1. Sufficient .....	156
	2. Not sufficient .....	121
B <sub>6</sub>	Cooking facilities:	
	1. Open fire .....	189
	2. Electricity .....	24
	3. Gas stove .....	64
B <sub>7</sub>	Cost per month:	
	1. R10 per month.....	244
	2. R30 per month.....	15
	3. R50 per month.....	8
B <sub>8</sub>	From where do you obtain wood?	
	2. Mostly from the veld .....	189
B <sub>9</sub>	Average distance to wood supply .....	10 km
B <sub>10</sub>	Housing details:	
	1. Owned .....	235
	2. Rented .....	42

- B<sub>11</sub>** Type of the house:
1. Traditional..... 194
  2. Rondavel .....51
  3. Modern .....32
- B<sub>12</sub>** Type of toilet used:
1. Mostly pit ..... 194
- B<sub>13</sub>** Preparedness to pay for water and housing..... none
- B<sub>14</sub>**
1. Women groups ..... 105
  2. Church groups ..... 129
  3. Farmers groups .....43
- B<sub>15</sub>** Name of the most important group: Church group.
- B<sub>16</sub>** Projects in the area:  
Agricor projects, Thusano Foundation and Population Development projects
- B<sub>17</sub>** Almost all the projects were unseccessful.
- B<sub>18</sub>** The reasons: Not well managed.

B <sub>19</sub>		C <sub>1</sub>
Available skills	Total number	Type of projects
Sowing	107	Income generation
Knitting	58	Income generation
Poultry	13	Income generation
Nurcing	54	Job creation
Builders	20	Job creation
Plumbers	17	Job creation
Electriciens	10	Job creation

C <sub>2</sub>		C <sub>3</sub>		C <sub>4</sub>	
Kind of jobs		Major needs		Crops improvement	
Any job	159	Improve life	126	Soil treatment	98
Teaching	70	Jobs	151	Credit	124
Mechanic	48			Technical assist	55

C <sub>5</sub>		C <sub>6</sub>	
Livestock improvement		Summer crops area	
Dipping	168	Maize	51 ha
Extension	87	Wheat	39 ha
Drug	22	Sorghum	18 ha

C<sub>7</sub> Average winter crop produced not available in many villages.

C <sub>8</sub>		C <sub>9</sub>		C <sub>10</sub>	
Who ploughs your land		Interested in having oxen, tractor		How much money can you pay	
Self	197	Not interested	159	Not knowing	187
Neighbour	19	Interested	114	About R100/month	57
Contractors	61	As a gift	4	Do not want	33

C<sub>11</sub> Average number of livestock per farmer:

Small farmers		Large farmers
Cattle	65 head	300 head
Sheep	48 head	215 head
Goats	31 head	125 head
Horses	2 head	9 head
Donkeys	8 head	15 head
Poultry	25 head	40 head

D<sub>2</sub> Statistics provided were not correct and were rejected.

D<sub>3</sub> Statistics disclosed were not correct and were rejected.

*APPENDIX A<sub>4</sub>*

*The probability sampling procedures*

#### APPENDIX A<sub>4</sub>: The probability sampling procedures

This appendix presents the main steps followed in order to have a probability sample for this research. As in all applicable mathematical theories, it is necessary to define formally the concepts from which the theory is constructed; choosing the definitions in such a way as to make the required intuitive interpretations seem reasonable.

For the purpose of the present study, it was required that the following elements be put in order. The study was faced with a situation in which a measurement or observation was to be made. This was called a "random experiment". A list of all possible results or outcomes or realisations of the experiment was made. The individual outcomes were the points in the space constituted by the complete list. This was then called the sample space. These points could be disposed along the X-axis of cartesian coordinates. It is convenient, though not necessary, to visualise the sample space as the square grid of points obtained by regarding the points (x,y) as ordinary cartesian coordinates.

The sample space consists of the 36 points presented in the following manner:

(1,1); (1,2); (1,3);.....,(2,1)..(6,6).

An event represented by a single point in the space is called a simple or elementary event. However, events which are not simple are called compound events. The compound events required more than one point in their representation. For example, the event where the total score equals 7 can be represented by a set of points such as: (1,6); (2,5); (3,4); (4,3); (5,2) and (6,1); in the sense that, if you are to get a prize when the total score equals 7, you will then win when any of the following results (1,6); (2,5); (3,4); (4,3);.....(6,1) are obtained.

Randomisation is a process which results in equal probabilities being attached to all the points in the sample space. hence, if there are n equiprobable points in the space, each point must then have a probability equal to  $1/n$ , such as  $p(6) = (1/6)$ .

Using this procedure, the probability sampling was obtained as follows: Considering that  $p(6) \cdot p(6) = 1/36$ ; the following table was obtained:

$y_i$	2	3	4	5	6	7	8	9	10	11	12
$P(y_i)$	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{4}{36}$	$\frac{5}{36}$	$\frac{6}{36}$	$\frac{5}{36}$	$\frac{4}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$
$F(y_i)$	$\frac{1}{36}$	$\frac{3}{36}$	$\frac{6}{36}$	$\frac{10}{36}$	$\frac{15}{36}$	$\frac{21}{36}$	$\frac{26}{36}$	$\frac{30}{36}$	$\frac{33}{36}$	$\frac{35}{36}$	$\frac{36}{36}$

$$y_i = x_1 \cdot x_2 \text{ or } p(6) \cdot p(6) = 1/6 \cdot 1/6 = 1/36$$

**APPENDIX A<sub>5</sub>**

*Treatment of statistical problems of the model*

## APPENDIX A<sub>5</sub>: Treatment of statistical problems of the model

**Heteroscedasticity:** This econometric problem is due to the variance of the error which varies from one observation to another as shown in equation (48):

$$V(\epsilon_i) = E(\epsilon_i^2) = \sigma_{\epsilon_i}^2 \quad (48)$$

In the presence of heteroscedasticity, the estimators of multiple regression coefficients are not efficient. In order to detect the presence of heteroscedasticity, different tests can be used, namely:

- (i) Park test (34(4):888, 1972) defined in equation (49).

$$\sigma_{\epsilon_i}^2 = \sigma^2 \cdot X_{ji}^\beta \cdot \epsilon^{v_i} \quad (49)$$

or 
$$\ln \sigma_{\epsilon_i}^2 = \ln \sigma^2 + \beta \ln x_{ji} + v_i \quad (50)$$

- (ii) Glejser test (64:316-323, 1969) defined by the following expression:

$$|\epsilon_i| = f(x_{ji}) \quad (51)$$

- (iii) Goldfield and Quandt test (60:539-547, 1965) can be defined as provided in equation (52):

$$G1 = \frac{\sum_{\epsilon_i_2}^2}{\sum_{\epsilon_i_1}^2} \approx F \quad G1 = \frac{\sum_{\epsilon_i_2}^2}{\sum_{\epsilon_i_1}^2} \approx F \quad (52)$$

To bring about a solution to the problem of heteroscedasticity, the original model should be transformed and multiplied by the terms of transformation. This can be done following Park (34(4):888, 1972) in the following manner:

Given the model expressed in equation (53), a transformation can be done

$$Y_i = \alpha + \beta x_i + \epsilon_i ; \epsilon_i \approx N(\sigma, \sigma_{\epsilon_i}^2) \quad (53)$$

by multiplying the model by the term such as:

$$w_i = \frac{1}{\sigma\epsilon_i} \quad (54)$$

This will result in the equation (55):

$$\frac{Y_i}{\sigma\epsilon_i} = \frac{\alpha_i}{\sigma\epsilon_i} + \frac{\beta x_i}{\sigma\epsilon_i} + \frac{\epsilon_i}{\sigma\epsilon_i} \quad (55)$$

and where:  $\frac{Y_i}{\sigma\epsilon_i} = v_i$  is the error of the transformation of the model,

$$\text{with } \Sigma(v_i) = \left(\frac{\epsilon_i}{\sigma\epsilon_i}\right) = 0 \quad (56)$$

$$V(v_i) = \Sigma(v_i^2) = \left(\frac{\epsilon_i}{\sigma\epsilon_i}\right)^2 = \frac{\sigma\epsilon_i^2}{\sigma^2\epsilon_i} = 1 \quad (57)$$

where: 1 represents a constant variance with the value of 1 or heteroscedasticity.

## AUTOCORRELATION

This econometric problem has a reciprocal relationship or connection between the successive coefficients of the same variable by influencing the degree of its magnitudes. Autocorrelation in the coefficients of regression might be attributed to various sources, e.g. see Durbin and Watson (38:159-178, 1976 and 27:409-428):

- (i) Behaviour characteristics of many of economic variables might be increasing, and
- (ii) Omission of an explanatory variable in the model might have a cause for autocorrelation, e.g.

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \epsilon_i \quad (58)$$

where:  $x_1$  = price of the product;

$x_2$  = income, and

$\beta$  and  $\epsilon_i$  are the respective regression coefficients and error.

It is expected that the prices of the products increase always from one year to another. From this assumption, the model should be rewritten or reformulated as expressed in equation (59).

$$Y = \beta_0 + \beta_1 x_1 + \epsilon^* \quad (59)$$

where:  $\epsilon^* = \beta_2 x_2 + \epsilon =$  error of specification of the model.

If  $x_2$  increases every year, then  $\epsilon^*$  represents autocorrelation.

To bring about the solution to the problem of autocorrelation, it is important to consider the model specification and to maintain its form. If the problem exists in the model specification, then it would be necessary to transform the original model based on the coefficients of the autocorrelation  $\rho$  (rho) of the Least-squares regression.

Following Durbin and Watson (38:159-178, 1976; and 27:409-428) this can be done by the following:

Given:

$$Y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \dots + \beta_k x_{kt} + \epsilon \quad (60)$$

This implies that:

$$V_t \approx N(0, \sigma_v^2) \quad (61)$$

It follows that for any period (t-1) the model could be expressed in the following manner:

$$Y_{t-1} = \beta_0 + \beta_1 x_{t-1} + \dots + \beta_k x_{kt-1} + \epsilon_{t-1} \quad (62)$$

Multiplying by the coefficient of autocorrelation term  $\rho$ , the following expression is obtained:

$$\rho Y_{t-1} = \rho\beta_0 + \rho\beta_1 x_{1t-1} + \dots + \rho\epsilon_{t-1} \quad (63)$$

Substituting expression (62) into (63) the model becomes then:

$$Y_t - \rho Y_{t-1} = \beta_0(1-\rho) + \beta_1(x_{1t} - x_{1t-1}) + \dots + \epsilon_t - \rho\epsilon_{t-1} \quad (64)$$

Briefly this can be expressed in the following form:

$$V_t = \epsilon_t - \rho\epsilon_{t-1} \quad (65)$$

Which provides a transformed model in which  $\rho$  is the coefficient of autocorrelation of the Least-squares regression.

## MULTICOLLINEARITY

Multicollinearity is due to an interrelationship between independent variables ( $x_i$ ) of the model. Normally, it is a problem of the magnitude of coefficients. However, the nonexistence of multicollinearity means lower magnitudes of the coefficients of  $x_i$ . In contrast, the higher magnitude of coefficient  $x_i$  means the presence of multicollinearity in the independent variables (Kmenta, 1978:411-423).

Multicollinearity is not a natural problem in the model, but it occurs mostly when one independent variable ( $x_i$ ) is highly correlated with another independent variable (Farrar and Glauber, 49:92-107, 1967). This has always been the case when a multiple regression analysis produces a coefficient of determination  $R^2$  of about 0,89 (Bennet, 28(1):19-20, 1969). However, a correlation of up to 0,90 can be accepted since the correlated variables are of great importance for the model (Goldberger, 1964:20-45).

Multicollinearity can be detected by using Farrar and Glauber test (49:92-107, 1967) and which can be expressed as given in the equation (66):

$$F^*_i = \frac{R^2_{x_i \ x_1 \dots \ x_k} / (k-1)}{(1-R^2_{x_i \ x_1 \dots \ x_k}) / (n-k)} \approx F \quad (66)$$

where:  $R^2$  = regression coefficient of  $x_i$ ;  
 $x_i$  = independent variables;  
 $k-1$  = degree of freedom of the numerator;  
 $n-k$  = degree of freedom of the denominator, and  
 $k$  = number of observations.

Thus, if  $F^* > F_{\text{tab}}$ , this indicates the presence of multicollinearity between independent variables ( $x_i$ ). For a solution to the problem of multicollinearity, it is necessary to eliminate all those variables with multicollinearity and to transform the model with the introduction of the new variables.

*APPENDIX B<sub>1</sub>*

*Maize producer prices: 1990-91*

APPENDIX B<sub>1</sub>: Maize producer prices (R/t), 1990-91

DELIVERY PRICES FOR MAIZE (1990/91 SEASON)

Class and grade of maize	Delivery price for uncleaned maize delivered in quantities of 65 kg or more in grain bags or in bulk		Delivery price for cleaned maize delivered in bulk in quantities of 65 kg or more		Delivery price for uncleaned maize delivered in smaller quantities than 65 kg	
	Standard rate R/t	Zero rate R/t	Standard rate R/t	Zero rate R/t	Standard rate R/5 kg	Zero rate R/5 kg
White maize						
WM1 .....	467,40	410,00	469,34	411,70	2,23	1,96
WM2 .....	452,58	397,00	454,52	398,70	2,17	1,90
WM3 .....	438,62	384,75	440,55	386,45	2,10	1,84
Yellow maize						
YM1 .....	467,40	410,00	469,34	411,70	2,23	1,96
YM2 .....	453,04	397,40	454,97	399,10	2,17	1,90
YM3 .....	438,62	384,75	440,55	386,45	2,10	1,84

Source: Bophuthatswana Agricultural Marketing Board, 1993

**MAIZE NET PRODUCER PRICES, 1990-91**

Class and grade of maize	Net producer's price for uncleaned maize delivered in quantities of 65 kg or more in grain bags or in bulk		Net producer's price for cleaned maize delivered in bulk in quantities of 65 kg or more		Net producer's price for uncleaned maize delivered in smaller quantities than 65 kg		Net producer's price for uncleaned sample class maize delivered in smaller quantities than 65 kg	
	1	2	3	4	5	6	7	8
	Standard rate R/t	Zero rate R/t	Standard rate R/t	Zero rate R/t	Standard rate R/5 kg	Zero rate R/5 kg	Standard rate R/5 kg	Zero rate R/5 kg
<b>White maize</b>								
WM1 .....	489,50	445,00	491,81	447,10	2,33	2,12	n.a.	n.a.
WM2 .....	475,53	432,30	477,84	434,40	2,27	2,06	n.a.	n.a.
WM3 .....	463,38	421,25	463,69	423,35	2,21	2,01	n.a.	n.a.
<b>Yellow maize</b>								
YM1 .....	469,50	445,00	491,81	447,10	2,33	2,12	n.a.	n.a.
YM2 .....	476,47	433,15	478,78	435,25	2,28	2,07	n.a.	n.a.
YM3 .....	463,38	421,25	465,69	423,35	2,21	2,01	n.a.	n.a.
Sample class maize	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2,33	2,12

Source: Bophuthatswana Agricultural Marketing Board, 1993

**GRAINSORGHUM, FLOOR PRICES (R/T)**

<b>Class and Grade</b>	<b>1990/91 (R/T)</b>	<b>1993/94 (R/T)</b>
GM	305	440
GL <sub>1</sub>	305	435
GL <sub>2</sub>	290	425
GH <sub>1</sub>	285	400
GH <sub>2</sub>	275	385

Source: Bophuthatswana Agricultural Marketing Board, 1993.

**OBSERVATION:** No floor prices were fixed during 1992/93 due to the lack of sorghum production in the area of study.

*APPENDIX B<sub>2</sub>*

*Wheat producer price, 1990-91*

APPENDIX B<sub>2</sub>: Wheat producer price, 1990-91

Class and grade	Gross delivery price		Net delivery price		Net producers delivery price
	VAT excluded	VAT inclusive	VAT for non registered producers	VAT for registered producers	
BPS	756,35	831,99	793,32	717,60	721,20
BP1	745,94	820,50	781,86	707,27	710,79
BSS	740,91	823,00	705,13	710,24	713,76
BS1	730,60	812,35	773,68	699,83	703,35
BS2	716,94	700,63	749,96	670,27	681,79
BL1	727,35	800,09	761,42	600,68	692,20
BL2	705,79	776,37	737,70	667,12	679,64
C1	708,76	779,64	740,97	670,09	673,61
C2	687,20	755,92	717,25	648,53	652,05
UT1	687,94	756,73	718,06	649,27	652,79
UT2	654,40	719,93	601,26	615,81	619,38
FG	350,00	385,00	346,33	311,33	314,85
D1	738,60	812,35	773,68	699,83	703,35
D2	716,94	700,63	749,96	678,27	601,79

Source: Bophuthatswana Agricultural Marketing Board, 1993.

Class and grade	Basic selling price (excluding VAT)	Less import and export restitution fund contribution (excluding VAT)	Less govt. aid (excluding VAT)	Less govt. aid [profit on import until fund is exhausted] (excluding VAT)	Gross selling price (before monthly price increase and supplementary payment to the Board)		Less supplyment (not subject to VAT)	Selling price (before monthly price increases)	
					VAT excl.	VAT incl.		VAT excl.	VAT incl.
BPS	761,35	16,35	18,00	72,86	654,14	719,55	7,12	647,02	712,43
BP1	750,94	16,35	18,00	72,86	643,73	708,10	7,12	636,61	700,98
BSS	753,91	16,35	18,00	72,86	646,70	711,37	7,12	639,58	704,25
BS1	743,50	16,35	18,00	72,86	636,29	699,92	7,12	629,17	692,80
BS2	721,94	16,35	18,00	72,86	614,73	676,20	7,12	607,61	669,08
BL1	732,35	16,35	18,00	72,86	625,14	687,65	7,12	618,02	680,53
BL2	710,79	16,35	18,00	72,86	603,58	663,94	7,12	596,46	656,82
C1	713,76	16,35	18,00	72,86	606,55	667,21	7,12	599,43	660,09
C2	692,20	16,35	18,00	72,86	584,99	643,49	7,12	577,87	636,37
UT1	692,94	16,35	18,00	72,86	585,73	644,30	7,12	578,61	637,18
UT2	659,48	16,35	18,00	72,86	552,27	607,50	7,12	545,15	600,38
FG	608,93	16,35	18,00	72,86	501,72	551,89	7,12	494,60	544,77
D1	743,50	16,35	18,00	72,86	636,29	699,92	7,12	629,17	692,80
D2	721,94	16,35	18,00	72,86	614,73	676,20	7,12	607,61	669,08

***APPENDIX B<sub>3</sub>***

*Hypothesis testing:  $X^2$  test for  $H_0$*

**APPENDIX B<sub>3</sub>: Hypothesis testing: X<sup>2</sup> test for H<sub>0</sub>**

The Chi-squared test (X<sup>2</sup>) is defined as expressed in equation (100).

$$X^2 = \sum \frac{(\sigma_i - \Sigma_i)^2}{\Sigma_i}$$

where:  $\Sigma$  = the sum of;

$\sigma_i$  = observed frequency, and

$\Sigma_i$  = expected frequency.

The class interval for both farmers is provided in the following table:

Class interval	Observed frequency	Expected frequency	$\sigma_i - \Sigma_i$	$(\sigma_i - \Sigma_i)^2$	$\frac{(\sigma_i - \Sigma_i)^2}{\Sigma_i}$
25-29	8	10	-2	4	0,40
30-34	15	13	2	4	0,31
35-39	16	19	-3	9	0,47
40-44	26	30	-4	16	0,53
45-49	21	25	-4	16	0,64
50-54	26	33	-7	49	1,48
55-59	14	12	2	4	0,33
60-64	15	18	-3	9	0,50
65-69	12	14	-2	4	0,28
+70	6	12	-6	36	3,00
Total	159	186	-27	151	7,94

The objective of the statistic  $X^2$  was to test the null hypothesis (HO) which postulates that there is a good agreement between the observed and expected frequencies defining the role of agriculture for accelerated development in the area of study. The alternative hypothesis, however, was that the agreement between the frequencies is not good. Hence, HO can be rejected at some specific level of significance such as  $\alpha = 0,05$ .

Concerning the study sample,  $X^2$  has  $10-1 = 9$  df. The corresponding tabulated values are  $P = 0,05$  while  $X^2 = 16,9$  and  $P = 0,95$  while  $X^2 = 3,32$ .

The calculated  $X^2$  for the sample is 7,94; a value which is within the acceptance region. In fact, the calculated  $X^2$  ( $\gamma = 9$  df) of 7,94 lies between the tabulated probabilities  $P = 0,10$  and  $P = 0,50$ ; which lies under the tail of the curve. This is:

$$0,10 < P(\text{calculated } X^2) < 0,50$$

Therefore, the HO can be accepted as the agreement between the observed and expected values are not bad, and that it can be rejected at the 5% level of significance.

***APPENDIX C<sub>1</sub>***

***Squared partial correlation***

**APPENDIX C<sub>1</sub>: Squared partial correlation type I, squared semi-partial correlation type II, squared partial correlation type II, tolerance and variance inflation, maize production**

<b>Variables</b>	<b>Squared partial corr. type I</b>	<b>Squared semi- partial corr. type II</b>	<b>Squared partial corr. type II</b>	<b>Tolerance</b>	<b>Variance inflation</b>
Intercept	-	-	-	-	0,00000
$\ln x_{t-1}$	0,10904	0,00388	0,00476	0,02615	38,23488
$\ln x_1$	0,02846	0,02722	0,03246	0,01280	78,12204
$\ln x_2$	0,09983	0,02781	0,03313	0,00886	112,84930
$\ln x_3$	0,00168	0,04666	0,05437	0,11764	8,50079
$\ln x_4$	0,00067	0,01303	0,01579	0,37940	2,63573
$\ln x_5$	0,06371	0,05523	0,06371	0,18587	5,38020

*APPENDIX C<sub>2</sub>*

*Squared partial correlation*

**APPENDIX C<sub>2</sub>: Squared partial correlation type I, squared semi-partial correlation type II, squared partial correlation type II, tolerance and variance inflation, wheat production**

<b>Variables</b>	<b>Squared partial corr. type I</b>	<b>Squared semi-partial corr. type II</b>	<b>Squared partial corr. type II</b>	<b>Tolerance</b>	<b>Variance inflation</b>
<b>Intercept</b>	-	-	-	-	0,00000
<b>lnx<sub>t-1</sub></b>	0,43818	0,03940	0,11031	0,03621	27,61582
<b>lnx<sub>1</sub></b>	0,21857	0,20612	0,39341	0,04924	20,30742
<b>lnx<sub>2</sub></b>	0,40249	0,11364	0,26339	0,06483	15,42476
<b>lnx<sub>3</sub></b>	0,17052	0,11764	0,27015	0,21099	4,73949
<b>lnx<sub>4</sub></b>	0,07027	0,06184	0,16289	0,16089	6,21553
<b>lnx<sub>5</sub></b>	0,11667	0,04198	0,11667	0,37857	2,64150