DEVELOPING A MARKETING MODEL TO ASSIST FREE STATE SWINE PRODUCERS TO MAXIMIZE PROFITS

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DECLARATION

I, Uboegbulam, Gideon Chukwunwem with student number do hereby declare that this research report titled: *"Developing a Marketing Model to assist Free State swine producers to maximize profits"* submitted to the Central University of Technology, Free State (CUT) for the award of a degree in Doctor of Management: Marketing Management is solely my independent work and has not been previously submitted by me to any other university/faculty.

14/08/2019

SIGNATURE OF STUDENT **DATE**

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ABTRACT

Swine production in the past decades has increased tremendously. The turn of the previous millennium witnessed the agricultural product market changing from a predominantly producer dominated market approach to a demanding, well informed, consumer dominated market. Generally speaking, the agricultural industry had become more industrialized and more specialized. Swine production world over has increased due to technological advancements. Recently, the outbreak of swine fever (H5N1) in most part of the world, including South Africa has caused a lot of panic to the industry. This has led to the decline of swine consumption with a concomitant effect on swine production in most parts of the world, including the Free State Province of South Africa. In view of the aforementioned predicaments, it is then imperative that marketing professionals should come to the aid of swine producers by developing an effective marketing model that will assist them to maximize their profit.

Therefore, primary objective of this study was aimed at developing a Marketing Model to assist Free State swine producers to maximize profits. The secondary objectives were: To Formulate the stocking rate to be adopted by swine producers in Free State. To determine the effect of distance to the market/abattoir on transportation cost. To determine to what extent Production cost, affect Gross income of Swine Producers in Free State. To determine to what extent the government agricultural policy affects Gross income of swine producers in Free State. To determine the extent access to bank loan affects Gross income of Swine Producers in Free State.

Primary Data and Secondary Data sources were used for data collection in this study, but the overall focal point was with the primary data. The primary objective of this work which was to develop a Marketing Model that will assist Free State swine producers to maximize profit was achieved through the use of Primary Data and Secondary Data sources. The result of the quantitative survey was presented in Frequency Tables, Percentages, Means, Pearson Product Moment Correlation Co-efficient (PPMC), Regression analysis and t-test, analysis of variance (ANOVA). For the purpose of this study, the results of the quantitative survey were presented in Frequency Tables, Percentages, Means, Pearson Product Moment Correlation Co-efficient (PPMC), Regression analysis and t-test, analysis of variance (ANOVA).

Analysis showed that access to government agricultural subsidy does not significantly affect Gross income of Swine Producers in Free State. The tested hypothesis proved that access to bank loan does not significantly affect Gross income of Swine Producers in Free State. Results from this study indicated that Production cost significantly affects Gross income of Swine Producers in Free State.

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CHAPTER 1

INTRODUCTION

1.1 Background to the Study

Swine are of high economic importance, especially among the poor. According to Antwi and Seahlodi (2011); Dietze (2011); Mergenthaler, Weinberger and Qaim (2009), they contribute to human nutrition, food security, poverty alleviation, enhanced livelihood and creation of employment for the rural community. In addition, they provide a less-expensive source of animal protein for urban diets compared with cattle, sheep and goats (Ironkwe & Amefule, 2008). Whilst Swine farming, as part of animal agriculture, is central to the development of rural farmers. The tangible contribution of emerging small-scale swine farmers (ESSSF) to the rural economy is not well assessed and somewhat doubtful. These economic contributions by ESSSF are constrained by management, health, housing, feeding and marketing constraints (Antwi & Seahlodi, 2011; Chikazunga et al., 2007).

In South Africa, it is estimated that there were approximately 125 000 production sows in 2010/2011, with approximately 100 000 sows being held commercially and the remaining 25 000 being kept by small-scale farmers. The South African pork industry contributes about 2.15% to the primary agricultural sector, and whilst 2 616 000 pigs were slaughtered in 2011, the total pork production was put at 203 375 tonnes in cold dressed mass (Food and Agriculture Organization Corporate Statistical Database [FAOSTAT] 2014).

Swine farming in South Africa had developed into a national industry with an estimated 1,613 million pigs in 2009 (DAS, 2010). Swine production contributes around 2.15% to the primary agricultural sector in South Africa (DAFF 2011). Over 400 South African pork producers manage 100,000 sows and produce more than 150 metric tons annually (DAFF 2012). Pork production was projected to respond to lower feed prices and increase to about 170,000 tons in 2010. Pork is produced throughout South Africa with Limpopo and North West province taking the lead accounting for 44% of the total production (i.e. Limpopo 24% and North West 20%). Free State contributed 8% of the total annual production (FAOSTAT, 2014).

Like in any animal production system feeding costs for swine are extremely high, and under communal farming conditions, feed resources are scarce and even if available price are prohibitive. However, local pigs are generally easy to feed, because they are hardy and can survive and reproduce on low plane of nutrition (Holness, 1991). Communal farmers generally

raise pigs in small herds using family labour and local available feed stuffs. In general, local swine are scavengers and have a higher capacity to utilize fibrous feed. They obtain their feeds from fields, woodlands, human food by-products and waste. Lack of marketing facilities imposes a serious constraint on the marketing of pigs (Mahabile et al., 2002). Marketing consists of the commercial functions involved in transferring of goods and services from producers/sellers to consumers/buyers (Kwon et al., 2007; Branson & Norvell, 1983). Essentially, it is the process of creating or directing an organization to be successful in selling a product or service that people not only desire, but are willing to buy. Marketing is not just the final transactions of receiving a cheque. The acts of buying supplies, renting equipment, paying labour, advertising, processing, distribution and selling are all part of marketing. It is also concerned with anticipating the customers' future needs and wants, which are often discovered through market research (Branson & Norvell, 1983).

An improvement in swine production and marketing especially in the rural sector could improve the livelihoods of the resource-poor farmers (Hall, 1998). Swine farmers in the Free State Province of South Africa face the challenge of marketing their product with a maximum profit due to lack of the knowledge of Production cost, Marketing Model/Chanel to follow. Moreover, the changing marketing environment and the problem associated with swine production (including the outbreak of HINI virus) have necessitated the consideration of developing a marketing model to assist Free State swine producers to maximize profits. Changes in the agri-business sector are caused by changes in distribution channels, the environment (i.e. external environment), agricultural producers and the consumer. The discrepancy between consumer acceptance and consumer rejection, especially of agricultural products like pork meat can be seen as a very thin edge between prejudice and perception. However, the development of a marketing model to assist Free State swine producers will bring relief to the producers and confident back to the business.

1.2 Motivation of the Study

The traditional approach to examining cattle feeding profitability focuses on allocating net returns into two components: (1) gain per head attributable to price changes from the time the feeder was purchased until it was sold, and (2) the returns associated with the increase in weight times the difference between the sale price per pound and feed cost per pound of gain (Heady & Jensen, 1954, Lambert & Sands, 1984; DAFF, 2010). Swanson (1959) and Meissner, Scholtz, and Palmer (2013) demonstrated that this typical division of returns to cattle feeding

was based on an arbitrary accounting convention and could not be supported by the theory of the firm.

Allocating returns to the feeder animal's price margin and the feeding margin gives the erroneous impression that the level of net returns to cattle feeding can be completely explained by these two factors. They proposed using coefficients of separate determination (Wright) to statistically estimate the relative importance of the buying and selling operation versus the feeding operation. Using Illinois Farm Bureau Farm Management Service records, they were able to explain 82 percent of the variation in net cattle feeding returns with 38 percent attributable to the price margin and 44 percent explained by the feed cost per pound of gain (Swanson & West, 1963; Meissner, Scholtz & Palmer, 2013).

In a related study focusing on the swine industry, Edwards et al. (1989) studied the relative importance of facility, feed, labor, operating, and health costs, sale prices, and reproductive performance on the profitability of farrow-to-finish swine operations in Iowa, U.S.A. They concluded that feed and facility costs were critical factors affecting variability in profits across producers.

The high degree of aggregation present in most existing studies means that little or no information is available regarding the specific effect of factors such as Stocking Rate, Distance to Market/Abattoir and Transportation Cost, Production Cost, Access to Government Agricultural Subsidy, Access to Bank Loan, and Membership to Swine organizations measures on profitability. The relative impact of various factors affecting profitability is an important ingredient in the development of Swine marketing models/strategies. Considering the fact that the Swine producers in the Free State especially the rural farmers lack knowledge of the factors mentioned above, this research will assist the farmers to maximize their profit. The study will come up with a Marketing Model/Strategies that will boost the profitability of Swine producers in the Province and the country at large.

Swine production world over has increased due to technological advancements. Recently, the outbreak of swine fever (H1N1) in most parts of the world, including South Africa has caused a lot of panic to the industry. This has led to the decline of swine consumption in the country including the Free State. It is then imperative that marketers should come to the aid of swine producers by developing an effective marketing model that will assist them to maximize their profit.

1.3 Problem Statement

A problem statement is a clear concise description of the issue(s) that need(s) to be addressed by a problem-solving team. It is used to center and focus the team at the beginning, keeps the team on track during the effort, and is used to ensure that the effort delivered an outcome that solves the problem statement.

There is no documented Marketing Model available to assist the Free State swine producers maximize profits, at least not the one the researcher is aware of. The traditional marketing system for swine by the Free State swine producers is characterized by independent producers and open market bargain. Most of the swine producers rely solely on prices negotiated in cash markets to establish base pork price. However, declining trade in cash pork markets makes using these markets as a base problematic. In particular, concerns regarding how representative cash prices are related to market conditions make their future use questionable. The extent to which this assertion is true for swine marketing in the Free State is uncertain, for the state of knowledge on livestock marketing largely comes from studies on cattle (Schonfeld, 2001), poultry (Ohlmann & Jones, 2008), sheep and goats (Dahlhoff, 2002).

Another area of interest is the marketing of swine product. Since the outbreak of swine virus known as H1N1, consumers seem to be very skeptical of the consumption of pork meat. Also, not to be overlooked is the religious belief of some who see pork meat as unclean. But still, it will take a long time to convince the consumers to see pork as healthy and nutritious meat.

1.3.1 Problem description

Swine producers typically market their pigs to several distributors, and a lack of uniformity in measuring and reporting carcass data exists among swine industries (Schonfeld, 2001). Because of this inconsistency, producers find it difficult, if not impossible, to compare their market hogs with pigs from other operations. Moreover, most of the farmers do not have the knowledge of the best marketing channel to use in other to maximize their profit. Producers also have difficulty understanding and comparing carcass data from their own pigs sent to different abattoirs. Efforts have been made to help the farmers to reduce the production cost, distance to the abattoir and the stocking rate so as to boost the gross income of the farmers. Thus, there is an urgent need of developing an effective Marketing Model/channel for optimization of profit margin by the pork producers.

1.4 Objectives of the Study

1.4.1 Primary objective

- The primary objective is to develop a Marketing Model to assist Free State swine producers to maximize profit.

1.4.2 Specific objectives

The specific objectives are to:

- Formulate the stocking rate to be adopted by swine producers in Free State
- Determine the effect of distance to the market/abattoir on transportation cost.
- Determine to what extent Production cost, affect Gross income of Swine Producers in Free State
- Determine to what extent does government agricultural policy affects Gross income of swine producers in Free State
- Determine the extent does access to bank loan affect Gross income of Swine Producers in Free
- Evaluate how membership of swine organization affects Gross income of Swine Producers in Free State

1.5 The Research Questions

The research questions that need to be answered in this study include:

- What marketing model/channels should be adopted by swine producers in Free State
- To what extent does the stocking rate adopted affects swine producers in Free State
- To what extent does distance to the market/abattoir affect transportation cost
- To what extent does Production cost affect Gross income of Swine Producers in Free State
- Does government agricultural policy affect Gross income of swine producers in Free State
- To what extent does access to bank loan affect Gross income of Swine Producers in Free State
- Does membership of swine organization affect Gross income of Swine Producers in Free State

1.6 Research Hypotheses

A hypothesis is an informed prediction that provides an explanation for an observed event. An observed event is a measurable result or condition. If it cannot be measured, then a hypothesis cannot be formed, because it cannot be confirmed or rejected. In addition, a hypothesis typically takes the form of an 'if-then" statement so it can be tested in research protocols. In this research the null hypothesis will be used. A null hypothesis as seen by (Lavrakas, 2008) is one in which no difference (or no effect) between two or more variables is anticipated by the researchers. This follows the tenets of science in which empirical evidence must be found to disprove the null hypothesis before a claim can be laid in support for an alternative hypothesis that justifies some reliable difference (or effect) in whatever is being studied. The null hypothesis is typically stated in words to the effect that "A equals B." The concept of the null hypothesis is therefore, a central part of formal hypothesis testing.

The following null hypothesis will be considered:

- HO1 There is no significant difference in the marketing channels adopted by swine producers in Free State.
- HO2 There is no significant difference in the stocking rate adopted by swine producers in Free State.
- HO3 There is no significant relationship between distance to market/abattoir and transport cost.
- Ho4 Production cost does not significantly affect Gross income of Swine Producers in Free State
- Ho5 Access to government agricultural subsidy does not significantly affect Gross income of producers in Free State
- Ho6 Access to bank loan does not significantly affect Gross income of Swine Producers in Free State
- Ho7 Membership of swine organization does not significantly affect Gross income of Swine Producers in Free State
-

1.7 Methodology:

1.7.1 Research design

The study will be conducted using both qualitative and quantitative non-experimental research approaches.

Qualitative study: A qualitative study was designed to provide detailed empirical evidence about the existing marketing trends and practice by the swine producers in the Free State Province of South Africa. The individual swine producers from both commercial and small-holder units were selected to be as representative of the swine industry as possible. This component of the research was conducted by means of a semi-structured, open-ended questionnaire using the procedures of McMillan and Schumacher (2001).

The qualitative study concentrated on establishing current view among swine producers in the Free State Province towards the industry practice for managing pigs to marketing age, changing nature of marketing activity, marketing channels, marketing strategies, marketing prices, profit maximization and marketing barriers. These qualitative data afforded alternative perspectives on some of the key issues that was investigated through quantitative non-experimental analysis, particularly the different meanings attached to the concept of swine marketing strategies for maximization of profit. They also enabled evidence-based evaluation of industry and individual swine producers approaches to the marketing strategies and practice in the Free State Province. The swine producers were selected to reflect differences across the swine producers in terms of marketing intensity, swine management type, size and specialization, individual and industry interactions.

1.7.2 Population of the study

A research population is generally a large collection of individuals or objects that is the main focus of a scientific query. It is for the benefit of the population that researches are done. However, due to the large sizes of populations, researchers often cannot test every individual in the population because it is too expensive and time-consuming. A research population is also known as a well-defined recruitment of individuals or objects known to have similar characteristics. All individuals or objects within a certain population usually have a common, binding characteristic or trait (Explorable.com (Nov 15, 2009). In this study, the population consisted of 1304 swine producers within the Free State province of South Africa. Three local municipalities were chosen for the study based on their large production of pig. The local municipalities chosen includes: Maluti a Phofung with 215 pig farmers; Mangaung with 138 pig farmers; and Moghaka with 116 pig farmers (data collected from department of agriculture Free State). The estimated total number of pig farmers in the selected Local Municipalities was 469. Accessible population of 100 pig farmers was selected for the study. These were farmers who have been in the business for the past 5-15 years. The study was conducted in Bloemfontein/Botshabelo, Kroonstad, Thaba Nchu and Qwa-Qwa. These experimental sites

were chosen because of the preponderance of swine farms in the localities. Moreover, most of the swine producers are concentrated in the experimental sites selected.

1.7.3 Sample size and sampling techniques

A total of 80 swine producers were randomly selected for this study. The target audience that applied to the proposed study were 80 producers. For this study, 20 swine producers (n = 20) were recruited from each of the following swine producing areas in the Free State Province:

- Bloemfontein/Botshabelo;
- Kroonstad;
- Thaba-Nchu; and
- Qwa-Qwa

The study consisted of four exotic (Large White, Duroc, Berkshire, and Landrace) and two indigenous (Mukota and Kolbroek) pig breeds. These breeds were selected and used for this study mostly because they were the most important breeds of swine that were commonly reared in the Free State Province.

1.7.4 Data Collection Techniques

1.7.4.1 Qualitative data collection technique

Primary and secondary data as well as information from comprehensive literature surveys were used in this study. The principles identified in the literature then formed primary basis for the subsequent identification of the fundamental performance indicators through which marketing strategies in the Free State were evaluated. Market research projects/ surveys conducted through questionnaire administration to ascertain consumer perceptions, trends and preferences covering the period of 10 years were considered. Data were gathered by means of a semi-structured and open-ended questionnaire, which were distributed to the 80 swine producers at their various farms within Bloemfontein; Kroonstad; Thaba-Nchu and Qwa-Qwa. Questions were arranged in different Likert scale and the respondents were asked to indicate their degree of agreement with the statement or any kind of subjective or objective evaluation of the statement regarding the issues of swine marketing strategies. A pilot survey involving 10 swine producers within the study area were conducted to ascertain the validity and reliability of the instrument used.

1.7.4.2 Quantitative data collection technique

A point of departure for this study was a quantitative non-experimental study which, following the procedures of McMillan and Schumacher (2001) examined phenomena through the numerical representation of observations and statistical analysis. Hence this design helped in the study of naturally occurring variation in the independent and dependent variables without any intervention (by the researcher or anyone else) to equate cases prior to their exposure to the independent variable. It involved a systematic attempt to define, measure, and report on the relationships between various elements (namely individual swine producers, industry and marketing strategies in relation to profit maximization) that were investigated.

The purpose of quantitative non-experimental design is to determine whether the difference in frequencies between single and multiple marketing strategies for each time period was significant. Quantitative non-experimental research designs that were used were usually descriptive (subjects usually measured once). A descriptive study establishes only associations between variables (McMillan & Schumacher, 2001) A quantitative non-experimental design using the chi-square ($\chi 2$) test has become the most widely used measure of the significance to which experimental results support or refute a hypothesis. Applicable to any experiment where discrete results can be measured, it is used in almost every field of science.

1.7.5 Data analysis techniques

For the purpose of this study, the results of the quantitative survey were presented in Frequency Tables, Percentages, Means, Pearson Product Moment Correlation Co-efficient (PPMC), and Analysis of Variance (ANOVA).

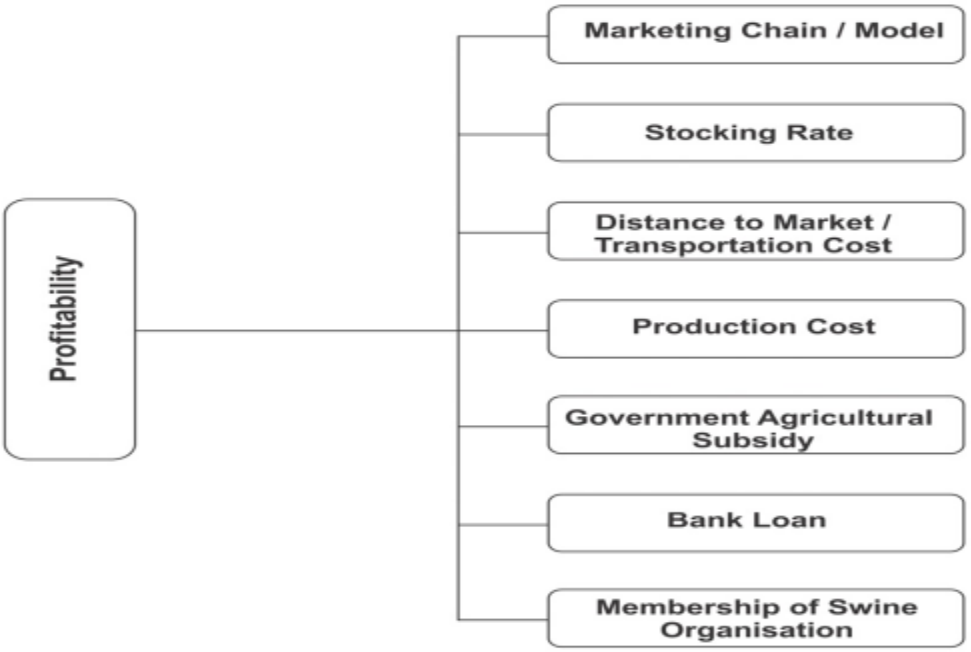
The data were extrapolated to quantify the amount of profit and the time trends of various marketing returns in line with the Statistical Analysis System (SAS), Version 9.1) (SAS, 2002). The chi-square ($\chi 2$) test was conducted to determine whether the difference in frequencies between single and multiple marketing strategies for each time period was significant (McDonald, 2008).

1.8 Limitations of study:

This study was conducted among selected Swine farmers in Free State province of South Africa hence the result could be said to be representative to the province. Moreover, the research covered only 5yrs – 15 of Swine producers in the study areas. There is no profit-oriented Marketing Model available for use by the Free State swine producers and the South African

swine industry in general at least not the one the researcher is aware of. Hence, development of an effective model will be done by drawing inferences from developed countries. Also, due to financial constraints, only a limited number (n= 80) of swine producers in the Free State were invited to participate in this study.

1.9 Conceptual Framework



Source: Researcher's Concept 2014

1.10 Chapter Layout and Work Plan

Chapter one covers the introduction, background and problem statement of the study. In chapter two, a discussion of the history and origin of swine production were presented. Chapter three concentrated on the marketing strategies that are used in swine marketing. Chapter four discussed the swine marketing models and the proposed marketing model for the study. Chapter five dealt with the research methodology employed in this work. Chapter six considered the findings of the research. Finally, chapter seven considered the recommendations and presentation of a new model.

CHAPTER 2

GENERAL OVERVIEW OF SWINE PRODUCTION

1.1 Introduction

Swine production has played an important role in the production of food for human consumption. As evidenced by the fact that pork consumption exceeds all other meat product throughout the world, it is apparent that pork plays a vital role in providing high quality protein to humankind (Steven & Francisco, 2004).

The swine industry in Free State is not as large as the poultry or beef industries, but it does have an impact on the Free State agricultural community and the economy. An archeological record indicates that the earliest domestication of swine started in Southwest Asia 9000 years ago (Bomber, 2001).

This chapter discusses the history of swine production around the world and in South Africa. Also, it considers the production processes, including the breeding systems, the products, the breeds available in South Africa, and the distribution both in the South African provinces and the world.

2.2 Overview of Livestock Production: Recent Trends, Future Prospects

The livestock sector globally is highly dynamic. In developing countries, it is evolving in response to rapidly increasing demand for livestock products. In developed countries, demand for livestock products is stagnating, (Thornton, 2010), while many production systems are increasing their efficiency and environmental sustainability. Historical changes in the demand for livestock products have been largely driven by human population growth, income growth and urbanization and the production response in different livestock systems has been associated with science and technology, as well as increases in animal population. In the future, production will increasingly be affected by competition for natural resources, particularly land and water, competition between food and feed and by the need to operate in a carbon-constrained economy. Developments in breeding, nutrition and animal health will continue to contribute to increasing potential production and further efficiency and genetic gains. Livestock production is likely to be increasingly affected by carbon constraints, environmental and animal welfare legislation. Demand for livestock products in the future could be heavily moderated by socio-economic factors such as human health concerns and changing socio-cultural values.

There is considerable uncertainty as to how these factors will play out in different regions of the world in the coming decades.

Livestock systems occupy about 30 per cent of the planet's ice-free terrestrial surface area (Steinfeld et al., 2006) and are a significant global asset with a value of at least $1.4 trillion. The livestock sector is increasingly organized in long market chains that employ at least 1.3 billion people globally and directly support the livelihoods of 600 million poor smallholder farmers in the developing world (Thornton et al., 2006). Keeping livestock is an important risk reduction strategy for vulnerable communities, and livestock are important providers of nutrients and traction for growing crops in smallholder systems. Livestock products contribute 17 per cent to kilocalorie consumption and 33 per cent to protein consumption globally, but there are large differences between rich and poor countries (Rosegrant et al., 2009).

Livestock systems have both positive and negative effects on the natural resource base, public health, social equity and economic growth (World Bank, 2009). Currently, livestock is one of the fastest growing agricultural subsectors in developing countries. Its share of agricultural GDP is already 33 per cent and is quickly increasing. This growth is driven by the rapidly increasing demand for livestock products, this demand being driven by population growth, urbanization and increasing incomes in developing countries (Delgado, 2005).

The global livestock sector is characterized by a dichotomy between developing and developed countries. Total meat production in the developing world tripled between 1980 and 2002, from 45 to 134 million tons (World Bank, 2009). Much of this growth was concentrated in countries that experienced rapid economic growth, particularly in East Asia, and revolved around poultry and pigs. In developed countries, on the other hand, production and consumption of livestock products are now growing only slowly or stagnating, although at high levels. Even so, livestock production and merchandizing in industrialized countries account for 53 per cent of agricultural GDP (World Bank, 2009). This combination of growing demand in the developing world and stagnant demand in industrialized countries represents a major opportunity for livestock keepers in developing countries, where most demand is met by local production, and this is likely to increase in the foreseeable future. At the same time, the expansion of agricultural production needs to take place in a way that allows the less well-off to benefit from increased demand and moderate impact on the environment.

2.2.1 Trends in livestock production and livestock systems evolution

(a) The increasing demand for livestock products

Human population in 2050 is estimated to increase to 9.15 billion, with a range of 7.96–10.46 billion (UNPD, 2008). Most of the increase is projected to take place in developing countries. East Asia will have shifted to negative population growth by the late 2040s (FAO, 2010). In contrast, population in sub-Saharan Africa (SSA) will still be growing at 1.2 per cent per year. Rapid population growth could continue to be an important impediment to achieving improvements in food security in some countries. Another important factor determining demand for food is urbanization. As of the end of 2008, more people now live in urban settings than in rural areas (UNFPA, 2008), with urbanization rates varying from less than 30 per cent in South Asia to near 80 per cent in developed countries and Latin America. The next few decades will see unprecedented urban growth, particularly in Africa and Asia. Urbanization has considerable impact on patterns of food consumption in general and on demand for livestock products in particular: urbanization often stimulates improvements in infrastructure, including cold chains, and these allow perishable goods to be traded more widely (Delgado, 2005). A third driver leading to increased demand for livestock products is income growth. Between 1950 and 2000, there was an annual global per capita income growth rate of 2.1 per cent (Maddison, 2003). As income grows, so does expenditure on livestock products (Steinfeld et al., 2006). Economic growth is expected to continue into the future, typically at rates ranging from between 1.0 and 3.1 per cent (van Vuuren et al., 2009). Growth in industrialized countries is projected to be slower than that in developing economies (Rosegrant et al., 2009).

The resultant trends in meat and milk consumption figures in developing and developed countries are shown in table 1, together with estimates for 2015–2050 (FAO, 2006; Steinfeld et al., 2006). Differences in the consumption of animal products are much greater than in total food availability, particularly between regions. Food demand for livestock products will nearly double in sub-Saharan Africa and South Asia, from some 200 kcal per person per day in 2000 to around 400 kcal per person per day in 2050. On the other hand, in most OECD countries that already have high calorie intakes of animal products (1000 kcal per person per day or more), consumption levels will barely change, while levels in South America and countries of the Former Soviet Union will increase to OECD levels (Van Vuuren et al., 2009).

The agricultural production sector is catering increasingly to globalized diets. Retailing through supermarkets is growing at 20 per cent per annum in countries such as China, India and

Vietnam, and this will continue over the next few decades as urban consumers demand more processed foods, thus increasing the role of agribusiness (Rosegrant et al., 2009).

(b) The production response

Global livestock production has increased substantially since the 1960s. Beef production has more than doubled, while over the same time chicken meat production has increased by a factor of nearly 10, made up of increases in both number of animals and productivity (figure 1). In the early 1960s to mid-2000s, Carcass weights increased to about 30 per cent for chicken and beef and by about 20 per cent for pigs (FAO, 2010). Carcass weight increases per head for camels and sheep are much less, about 5 per cent only over this time period. Increases in milk production per animal have amounted to about 30 per cent for cows' milk, about the same as for increases in egg production per chicken over the same time period (FAO, 2010).

Table 1 Past and Projected Trends in Consumption of Meat and Milk in Developing and Developed Countries.

Stages		Annual *per capita* consumption		total consumption	
		Meat (kg)	Milk (kg)	Meat (Mt)	Milk (Mt)
Developing	1980	14	34	47	114
	1990	18	38	73	152
	2002	28	44	137	222
	2015	*32*	*55*	*184*	*323*
	2030	*38*	*67*	*252*	*452*
	2050	*44*	*78*	*326*	*585*
Developed	1980	73	195	86	228
	1990	80	200	100	251
	2002	78	202	102	265
	2015	*83*	*203*	*112*	*273*
	2030	*89*	*209*	*121*	*284*
	2050	*94*	*216*	*126*	*295*

Data for 1980–2015 adapted from Steinfeld et al. (2006) and for 2030–2050 from FAO (2006).

N.B: Projections are shown in italic font.

These changes have been accompanied by substantial shifts in the area of arable land, pastures and forest. Arable and pasture lands have expanded considerably since the early 1960s,

although the rates of change have started to slow (Steinfeld et al., 2006). Over the last 20 years, large forest conversions have occurred in the Amazon Basin, Southeast Asia, and Central and West Africa, while forest area has increased owing to agricultural land abandonment in the Eurasian boreal forest and parts of Asia, North America, Latin America and the Caribbean (LAC) (GEO4, 2007). Considerable expansion of crop land planted to soybean (as a protein source in animal feed) has occurred in Latin America over the last 30 years. Developing countries' share of global use of cereals for animal feed nearly doubled (to 36%) from the early 1908s to the late 1990s (Delgado, 2005).

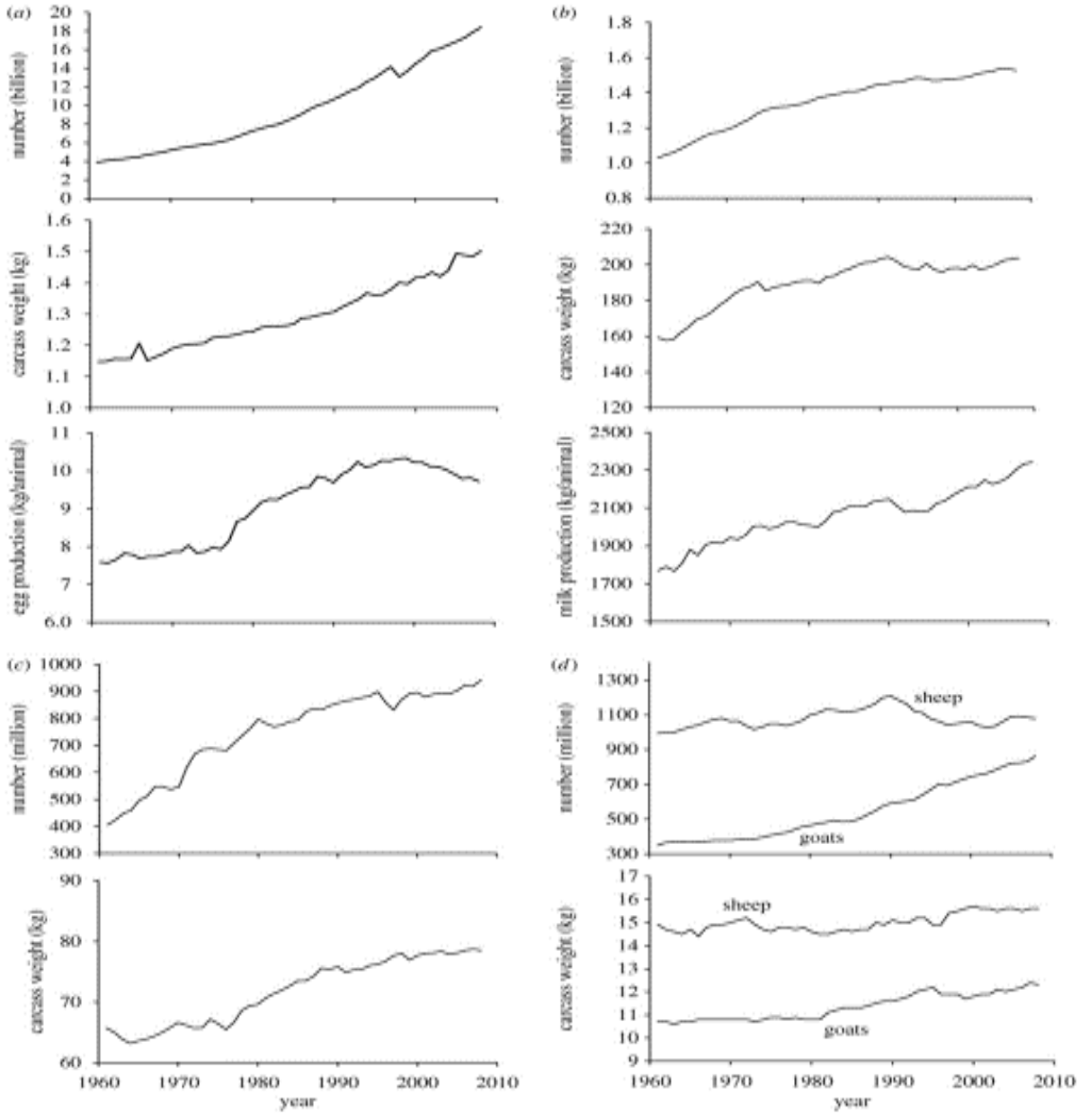


Figure 1: (*a*) Number of chickens, carcass weight and egg production per animal from 1961 to 2008, global. (*b*) Number of bovines (cattle and buffaloes), carcass weight and cattle milk production per animal from 1961 to 2008, global. (*c*) Number of pigs and carcass weight from

1961 to 2008, global. (*d*) Number of sheep, goats and carcass weights from 1961 to 2008, global. (*e*) Number of camels and carcass weight from 1961 to 2008, global. Data from FAO (2010).

Some cropland has been converted to other uses, including urban development around many major cities. Land-use intensity has increased in some places: cereal yields have trebled in East Asia over this time, while yields have not increased in sub-Saharan Africa, for example. Land-use change is complex and driven by a range of drivers that are regionally specific, although it is possible to see some strong historical associations between land abundance, application of science and technology and land-use change in some regions (Rosegrant et al., 2009). In Latin America, for instance, land abundance has slowed the introduction of new technologies that can raise productivity.

Historically, production response has been characterized by systems' as well as regional differences. Confined livestock production systems in industrialized countries are the source of much of the world's poultry and pig meat production, and such systems are being established in developing countries, particularly in Asia, to meet increasing demand. Bruinsma (2003) estimates that at least 75 per cent of total production growth in 2030 will be in confined systems, but there will be much less growth in these systems in Africa.

While crop production growth will come mostly from yield increases rather than from area expansion, the increases in livestock production will come about more as a result of expansion in livestock numbers in developing countries, particularly ruminants. In the intensive mixed systems, food-feed crops are vital ruminant livestock feed resources. The prices of food-feed crops are likely to increase at faster rates than the prices of livestock products (Rosegrant et al., 2009). Changes in stover production will vary widely from region to region into 2030 (Herrero et al., 2009). Large increases may occur in Africa mostly as a result of productivity increases in maize, sorghum and millet. Yet stover production may stagnate in areas such as the ruminant-dense mixed systems of South Asia, and stover will need to be replaced by other feeds in the diet to avoid significant feed deficits. The production of alternative feeds for ruminants in the more intensive mixed systems, however, may be constrained by both land and water availability, particularly in the irrigated systems (Herrero et al., 2009).

Meeting the substantial increases in demand for food will have profound implications for livestock production systems over the coming decades. In developed countries, carcass weight growth will contribute an increasing share of livestock production growth as expansion of

numbers is expected to slow; numbers may shrink in some regions. Globally, however, between 2000 and 2050, the global cattle population may increase from 1.5 billion to 2.6 billion, and the global goat and sheep population from 1.7 billion to 2.7 billion (figure 2; Rosegrant et al., 2009). Ruminant grazing intensity in the rangelands is projected to increase, resulting in considerable intensification of livestock production in the humid and sub humid grazing systems of the world, particularly in LAC.

The prices of meats, milk and cereals are likely to increase in the coming decades, dramatically reversing past trends. Rapid growth in meat and milk demand may increase prices for maize and other coarse grains and meals. Bioenergy demand is projected to compete with land and water resources, and this will exacerbate competition for land from increasing demands for feed resources. Increasing scarcities of water and land will require substantially increased resource use efficiencies in livestock production to avoid adverse impacts on food security and human wellbeing goals. Higher prices can benefit surplus agricultural producers, but can reduce access to food by a larger number of poor consumers, including farmers who do not produce a net surplus for the market. As a result, progress in reducing malnutrition is projected to be slow (Rosegrant et al., 2009). Livestock system evolution in the coming decades is inevitably going to involve trade-offs between food security, poverty, equity, environmental sustainability and economic development.

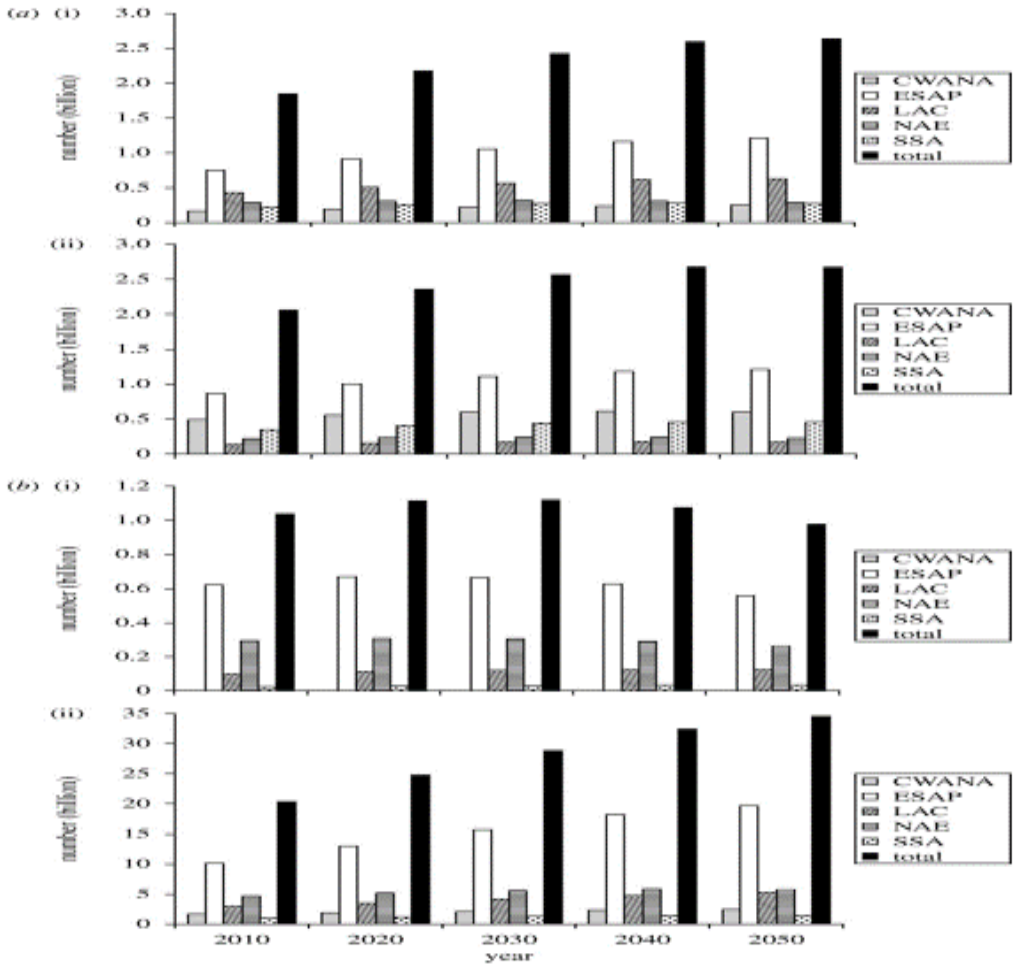


Figure 2: (a) Projected number of (i) bovines and (ii) sheep and goats to 2050 in the 'reference world'. (b) Projected number of (i) pigs and (ii) poultry to 2050 in the 'reference world', (CWANA), Central and West Asia and North Africa; (ESAP), East and South Asia and the Pacific; (LAC), Latin America and the Caribbean; (NAE), North America and Europe; (SSA), sub-Saharan Africa (Rosegrant et al., 2009).

2.2.3 Livestock science and technology as a driver of change

(a) Breeding and genetics

Historically, domestication and the use of conventional livestock breeding techniques have been largely responsible for the increases in yield of livestock products that have been observed over recent decades (Leakey et al., 2009). At the same time, considerable changes in the composition of livestock products have occurred. If past changes in demand for livestock products have been met by a combination of conventional techniques, such as breed substitution, cross-breeding and within-breed selection, future changes are likely to be met increasingly from new techniques.

Of the conventional techniques, breed selection or crosses is a one-off process, in which the most appropriate breed or cross-breds can be chosen, but further improvement can be made only by selection within the population (Simm et al., 2004). Cross-breeding, which is widespread in commercial production, exploits the complementarity of different breeds or strains and makes use of heterosis or hybrid vigour (Simm, 1998). Selection within breeds of farm livestock produces genetic changes typically in the range 1–3% per year, in relation to the mean of the single or multiple traits that are of interest (Smith 1984). Such rates of change have been achieved in practice over the last few decades in poultry and pig breeding systems in several countries and in dairy cattle breeding programmes in countries such as the USA, Canada and New Zealand (Simm, 1998), mostly because of the activities of breeding companies. Rates of genetic change achieved in national beef cattle and sheep populations are often substantially lower than what is theoretically possible. Ruminant breeding in most countries is often highly dispersed, and sector-wide improvement is challenging (Simm, 1998).

Rates of genetic change have increased in recent decades in most species in developed countries for several reasons, including more efficient statistical methods for estimating the genetic merit of animals, the wider use of technologies such as artificial insemination and more focused selection on objective traits such as milk yield (Simm et al., 2004). The greatest gains have been made in poultry and pigs, with smaller gains in dairy cattle, particularly in developed countries and in the more industrialized production systems of some developing countries. Some of this has been achieved through the widespread use of breed substitution, which tends to lead to the predominance of a few highly specialized breeds, within which the genetic selection goals may be specifically focused.

While most of the gains have occurred in developed countries, there are considerable opportunities to increase productivity in developing countries. Within-breed selection has not been practiced all that widely, in part because of the lack of the appropriate infrastructure needed (such as performance recording and genetic evaluation schemes). Breed substitution or crossing can result in rapid improvements in productivity, but new breeds and crosses need to be appropriate for the environment and to fit within production systems that have limited resources and other constraints. High-performing temperate breeds of dairy cow may not be appropriate for some developing-country situations: for example, heat stress and energy deficits make the use of Friesians in smallholdings on the Kenyan coast unsustainable, partly because of low cow replacement rates (King et al., 2006a). There is much more potential in the use of crosses of European breeds with local Zebus that are well-adapted to local conditions.

In the future, many developed countries will see a continuing trend in which livestock breeding focuses on other attributes in addition to production and productivity, such as product quality, increasing animal welfare, disease resistance and reducing environmental impact. The tools of molecular genetics are likely to have considerable impact in the future. For example, DNA-based tests for genes or markers affecting traits that are difficult to measure currently, such as meat quality and disease resistance, will be particularly useful (Leakey et al., 2009). Another example is transgenic livestock for food production; these are technically feasible, although the technologies associated with livestock are at an earlier stage of development than the equivalent technologies in plants. In combination with new dissemination methods such as cloning, could dramatically change livestock production. Complete genome maps for poultry and cattle now exist, and these open up the way to possible advances in evolutionary biology, animal breeding and animal models for human diseases (Lewin, 2009). Genomic selection should be able to at least double the rate of genetic gain in the dairy industry (Hayes et al., 2009), as it enables selection decisions to be based on genomic breeding values, which can ultimately be calculated from genetic marker information alone, rather than from pedigree and phenotypic information. Genomic selection is not without its challenges, but it is likely to revolutionize animal breeding.

As the tools and techniques of breeding are changing, so are the objectives of many breeding programmes. Although there is little evidence of direct genetic limits to selection for yield, if selection is too narrowly focused there may be undesirable associated responses (Simm et al., 2004); for example, in dairy cattle, where along with genetic gain in some production traits, there is now considerable evidence of undesirable genetic changes in fertility, disease incidence and overall stress sensitivity, despite improved nutrition and general management (Hare et al., 2006). Trade-offs are likely to become increasingly important, between breeding for increased efficiency of resource use, knock-on impacts on fertility and other traits and environmental impacts such as methane production. Whole-system and life-cycle analyses (‘cradle-to-grave’ analyses that assess the full range of relevant costs and benefits) will become increasingly important in disentangling these complexities.

New tools of molecular genetics may have far-reaching impacts on livestock and livestock production in the coming decades. But ultimately, whether the tools used are novel or traditional, all depend on preserving access to animal genetic resources. In developing countries, if livestock are to continue to contribute to improving livelihoods and meeting market demands, the preservation of farm animal genetic resources will be critical in helping livestock

adapt to climate change and the changes that may occur in these systems, such as shifts in disease prevalence and severity. In developed countries, the narrowing animal genetic resource base in many of the intensive livestock production systems demonstrates a need to maintain as broad a range of genetic resources as possible, to provide genetic insurance against future challenges and shocks. Institutional and policy frameworks that encourage the sustainable use of traditional breeds and *in situ* conservation need to be implemented, and more understanding is needed of the match between livestock populations, breeds and genes with the physical, biological and economic landscape (FAO, 2007).

(b) Nutrition

The nutritional needs of farm animals with respect to energy, protein, minerals and vitamins have long been known, and these have been refined in recent decades. Various requirement determination systems exist in different countries for ruminants and non-ruminants, which were originally designed to assess the nutritional and productive consequences of different feeds for the animal once intake was known. However, a considerable body of work exists associated with the dynamics of digestion, and feed intake and animal performance can now be predicted in many livestock species with high accuracy.

A well-defined agenda of operation still remains concerning the robust prediction of animal growth, body composition, feed requirements, the outputs of waste products from the animal and production costs. Such operational agenda could go a long way to help improve the efficiency of livestock production and meeting the expectations of consumers and the demands of regulatory authorities. Advances in genomics, transcriptomics, proteomics and metabolomics will continue to contribute to the field of animal nutrition and predictions relating to growth and development (Dumas et al., 2008). Better understanding of the processes involved in animal nutrition could also contribute to improved management of some of the trade-offs that operate at high levels of animal performance, such as those associated with lower reproductive performance (Butler, 2000).

While understanding of the science of animal nutrition continues to expand and develop, most of the world's livestock, particularly ruminants in pastoral and extensive mixed systems in many developing countries, suffer from permanent or seasonal nutritional stress (Bruinsma, 2003). Poor nutrition is one of the major production constraints in smallholder systems, particularly in Africa. Much research has been carried out to improve the quality and availability of feed resources, including work on sown forages, forage conservation, the use of multi-purpose trees,

fibrous crop residues and strategic supplementation. There are also prospects for using novel feeds from various sources to provide alternative sources of protein and energy, such as plantation crops and various industrial (including ethanol) by-products. The potential of such feeds is largely unknown. Given the prevalence of mixed crop–livestock systems in many parts of the world, closer integration of crops and livestock in such systems can give rise to increased productivity and increased soil fertility (McIntire et al., 1992). In such systems, smallholders use crops for multiple purposes (food and feed, for example), and crop breeding programmes are now well established that are targeting stover quality as well as grain yield in crops such as maize, sorghum, millet and groundnut.

Considerable work is under way to address some of the issues associated with various anti-nutritional factors. These include methods to reduce the tannin content of tree and shrub material, the addition of essential oils that may be beneficial in ruminant nutrition and the use of other additives, such as enzymes that can lead to beneficial effects on livestock performance. Enzymes are widely added to feeds for pigs and poultry, and these have contributed (with breeding) to the substantial gains in feed conversion efficiency that have been achieved.

What are the prospects for the future? For the mixed crop-livestock smallholder systems in developing countries, there may be places where these will intensify using the inputs and tools of high-input systems in the developed world. In the places where intensification of this nature will not be possible, there are many ways in which nutritional constraints could be addressed, based on what is locally acceptable and available. One area of high priority for additional exploration, which could potentially have broad implications for tropical ruminant nutrition, is microbial genomics of the rumen, building on current research into the breaking down of lignocelluloses for biofuels (NRC, 2009).

Addressing the nutritional constraints faced by pastoralists in extensive rangeland systems in the developing world is extremely difficult. While there is potential to improve livestock productivity in semi-arid and arid areas, probably the most feasible solutions require integrated application of what is already known, rather than new technology. This could involve dissemination of information from early warning systems and drought prediction, for example, so that herders can better manage the complex interactions between herd size, feed availability and rainfall (NRC, 2009).

For the developed world, various drivers will shape the future of livestock nutrition. First, there is the continuing search for increased efficiency in livestock production. Margins for livestock farmers are likely to remain volatile and may be affected heavily by changes in energy prices, and increased feed conversion efficiency is one way to try to keep livestock production profitable. Public health issues will become increasingly important, such as concerns associated with the use of antibiotics in animal production, including microbiological hazards and residues in food (Vallat et al., 2005). The World Health Organization recommended that all sub therapeutic medical antibiotic use be stopped in livestock production in 1997, and proposed strict regulation and the phasing-out of other sub therapeutic treatments such as growth promotants; but appropriate surveillance and control programmes do not exist in many countries (Leakey et al., 2009). All antibiotics as growth promoters were banned in the European Union (EU) in 2006, but not all countries have made the same choice as the EU. Similarly, certain hormones can increase feed conversion efficiencies, particularly in cattle and pigs, and these are used in many parts of the world. The EU has also banned the use of hormones in livestock production. The globalization of the food supply chain will continue to raise consumer concerns for food safety and quality.

Another key driver that will affect livestock nutrition is the need (or in countries such as the UK, the legal obligation) to mitigate greenhouse gas emissions. Improved feeding practices (such as increased amounts of concentrates or improved pasture quality) can reduce methane emissions per kilogram of feed intake or per kilogram of product, although the magnitude of the latter reduction decreases as production increases. Many specific agents and dietary additives have been proposed to reduce methane emissions, including certain antibiotics, compounds that inhibit methanogenic bacteria, probiotics such as yeast culture and propionate precursors such as fumarate or malate that can reduce methane formation (Smith et al., 2007). Whether these various agents and additives are viable for practical use or not, and what their ultimate impacts could be on greenhouse gas mitigation, are areas that need further research.

(c) Disease

Animal diseases generate a wide range of biophysical and socio-economic impacts that may be both direct and indirect, and may vary from localized to global (Perry & Sones, 2009). The economic impacts of diseases are increasingly difficult to quantify, largely because of the complexity of the effects that they may have, but they may be enormous: the total costs of foot-and-mouth disease in the UK may have amounted to $18–25 billion between 1999 and 2002 (Bio-Era, 2008).

The last few decades have seen a general reduction in the burden of livestock diseases, as a result of more effective drugs and vaccines and improvements in diagnostic technologies and services (Perry & Sones, 2009). At the same time, new diseases have emerged, such as avian influenza H5N1, which have caused considerable global concern about the potential for a change in host species from poultry to man and an emerging global pandemic of human influenza.

In the developing world, there have been relatively few changes in the distribution, prevalence and impact of many epidemic and endemic diseases of livestock over the last two decades, particularly in Africa (Perry & Sones, 2009), with a few exceptions such as the global eradication of rinderpest. Over this time, there has also been a general decline in the quality of veterinary services. A difficulty in assessing the changing disease status in much of the developing world is the lack of data, a critical area where progress needs to be made if disease diagnostics, monitoring and impact assessment are to be made effective and sustainable. Globally, the direct impacts of livestock diseases are decreasing, but the total impacts may actually be increasing, because in a globalized and highly interconnected world, the effects of disease extend far beyond animal sickness and mortality (Perry & Sones, 2009).

For the future, the infectious disease threat will remain diverse and dynamic, and combating the emergence of completely unexpected diseases will require detection systems that are flexible and adaptable in the face of change (King et al., 2006b). Travel, migration and trade will all continue to promote the spread of infections into new populations. Trade in exotic species and in bush meat are likely to be increasing causes of concern, along with large-scale industrial production systems, in which conditions may be highly suitable for enabling disease transmission between animals and over large distances (Otte et al., 2007).

Over the long term, future disease trends could be heavily modified by climate change. For some vector-borne diseases such as malaria, trypanosomiasis and bluetongue, climate change may shift the geographical areas where the climate is suitable for the vector, but these shifts are not generally anticipated to be major over the next 20 years: other factors may have much more impact on shifting vector distributions in the short term (Woolhouse, 2006). Even so, Van Dijk et al. (2010) have found evidence that climate change, especially elevated temperature, has already changed the overall abundance, seasonality and spatial spread of endemic helminths in the UK. This has obvious implications for policy-makers and the sheep and cattle industries, and raises the need for improved diagnosis and early detection of livestock parasitic

disease, along with greatly increased awareness and preparedness to deal with disease patterns that are manifestly changing.

Climate change may have impacts not only on the distribution of disease vectors. Some diseases are associated with water, which may be exacerbated by flooding and complicated by inadequate water access. Droughts may force people and their livestock to move, potentially exposing them to environments with health risks to which they have not previously been exposed. While the direct impacts of climate change on livestock disease over the next two to three decades may be relatively muted (King et al., 2006b), there are considerable gaps in knowledge concerning many existing diseases of livestock and their relation to environmental factors, including climate.

Future disease trends are likely to be heavily modified by disease surveillance and control technologies. Potentially effective control measures already exist for many infectious diseases, and whether these are implemented appropriately could have considerable impacts on future disease trends. Recent years have seen considerable advances in the technology that can be brought to bear against disease, including DNA fingerprinting for surveillance, polymerase chain reaction tests for diagnostics and understanding resistance, genome sequencing and antiviral drugs (Perry & Sones, 2009). There are also options associated with the manipulation of animal genetic resources, such as cross-breeding to introduce genes into breeds that are otherwise well-adapted to the required purposes, and the selection via molecular genetic markers of individuals with high levels of disease resistance or tolerance.

The future infectious disease situation is going to be different from today's (Woolhouse, 2006), and will reflect many changes, including changes in mean climate and climate variability, demographic change and different technologies for combating infectious diseases. The nature of most, if not all, of these changes is uncertain, however.

2.2.4 Possible modifiers of future livestock production and consumption trends

(a) Competition for resources

(i) Land

Recent assessments expect little increase in pasture land (Bruinsma, 2003; MA, 2005). Some intensification in production is likely to occur in the humid and sub-humid zones on the most suitable land, where this is feasible, through the use of improved pastures and effective management. In the more arid–semiarid areas, livestock are a key mechanism for managing

risk, but population increases are fragmenting rangelands in many places, making it increasingly difficult for pastoralists to gain access to the feed and water resources that they have traditionally been able to access. In the future, grazing systems will increasingly provide ecosystem goods and services that are traded, but how future livestock production from these systems may be affected is not clear. The mixed crop–livestock systems will continue to be critical to future food security, as two-thirds of the global population live in these systems. Some of the higher potential mixed systems in Africa and Asia are already facing resource pressures, but there are various responses possible, including efficiency gains and intensification options (Herrero et al., 2010). Increasing competition for land in the future will also come from biofuels, driven by continued concerns about climate change, energy security and alternative income sources for agricultural households. Future scenarios of bioenergy use vary widely (Van Vuuren et al., 2009), and there are large evidence gaps concerning the likely trade-offs between food, feed and fuel in production systems in both developed and developing countries, particularly related to second-generation bioenergy technology.

(ii) Water

Globally, freshwater resources are relatively scarce, amounting to only 2.5 per cent of all water resources (MA, 2005). Groundwater also plays an important role in water supply: between 1.5 and 3 billion people depend on groundwater for drinking, and in some regions water tables are declining unremittingly (Rodell et al., 2009). By 2025, 64 per cent of the world's population will live in water-stressed basins, compared with 38 per cent today (Rosegrant et al., 2002). Increasing livestock numbers in the future will clearly add to the demand for water, particularly in the production of livestock feed: one cubic metre of water can produce anything from about 0.5 kg of dry animal feed in North American grasslands to about 5 kg of feed in some tropical systems (Peden et al., 2007). Several entry points for improving global livestock water productivity exist, such as increased use of crop residues and by-products, managing the spatial and temporal distribution of feed resources so as to better match availability with demand and managing systems so as to conserve water resources (Peden et al., 2007). More research is needed related to livestock–water interactions and integrated site-specific interventions, to ensure that livestock production in the future contributes to sustainable and productive use of water resources (Peden et al., 2007).

(b) Climate change

Climate change may have substantial effects on the global livestock sector, and livestock production systems are presumed to be affected in various ways with inevitable changes in productivity (table 2.2; Thornton et al., 2009). Increasing climate variability will undoubtedly increase livestock production risks as well as reduce the ability of farmers to manage these risks. At the same time, livestock food chains are major contributors to greenhouse gas emissions, accounting for perhaps 18 per cent of total anthropogenic emissions (Steinfeld et al., 2006). Offering relatively fewer cost-effective options than other sectors such as energy, transport and buildings, agriculture has not yet been a major player in the reduction of greenhouse gas emissions. This will change in the future (UNFCCC, 2008), although guidance will be needed from rigorous analysis; for example, livestock consumption patterns in one country are often associated with land-use changes in other countries, and these have to be included in national greenhouse gas accounting exercises (Audsley et al., 2009).

Table 2.2 Direct and indirect impacts of climate change on livestock production systems (adopted from Thornton & Gerber, 2010).

Grazing systems	Non-grazing systems
direct impacts	
extreme weather events	water availability
drought and floods	extreme weather events
productivity losses (physiological stress) owing to temperature increase	
water availability	
indirect impacts	
agro-ecological changes:	increased resource price, e.g. feed and energy
fodder quality and quality	disease epidemics
host–pathogen interactions	increased cost of animal housing, e.g. cooling systems
disease epidemics	

Climate change will have severely deleterious impacts in many parts of the tropics and subtropics, even for small increases in the average temperature. This is in contrast to many parts of the temperate zone; at mid- to high latitudes, agricultural productivity is likely to

increase slightly for local mean temperature increases of 1–3°C (IPCC 2007). There is a burgeoning literature on adaptation options, including new ways of using weather information to assist rural communities in managing the risks associated with rainfall variability and the design and piloting of livestock insurance schemes that are weather-indexed (Mude 2009). Many factors determine whether specific adaptation options are viable in particular locations. More extensive adaptation than is currently occurring is needed to reduce vulnerability to future climate change, and adaptation has barriers, limits and costs (IPCC, 2007).

Similarly, there is a burgeoning literature on mitigation in agriculture. There are several options related to livestock, including grazing management and manure management. Global agriculture could offset 5–14% (with a potential maximum of 20%) of total annual CO_2emissions for prices ranging from $20 to 100 per t CO_2 eq (Smith et al. 2008). Of this total, the mitigation potential of various strategies for the land-based livestock systems in the tropics amounts to about 4 per cent of the global agricultural mitigation potential to 2030 (Thornton & Herrero submitted), which could still be worth of the order of $1.3 billion per year at a price of $20 per t CO_2 eq. Several of these mitigation options also have adaptive benefits, such as growing agroforestry species that can sequester carbon, which can also provide high-quality dietary supplements for cattle. Such carbon payments could represent a relatively large amount of potential income for resource-poor livestock keepers in the tropics. In the more intensive systems, progress could be made in mitigating GHG emissions from the livestock sector via increases in the efficiency of production using available technology, for the most part, and this may involve some shifting towards monogastric species.

(c) Socio-cultural modifiers

Social and cultural drivers of change are having profound effects on livestock systems in particular places, although it is often unclear how these drivers play out in relation to impacts on livestock and livestock systems. Livestock have multiple roles in human society. They contribute substantially and directly to food security and to human health. For poor and under-nourished people, particularly children, the addition of modest amounts of livestock products to their diets can have substantial benefits for physical and mental health (Neumann et al., 2003).

Livestock's contribution to livelihoods, particularly those of the poor in developing countries, is also well recognized. Livestock generate income by providing both food and non-food products that the household can sell in formal or informal markets. Non-food products such as wool,

hides and skins are important sources of income in some regions: wool production in the high-altitude tropical regions of Bolivia, Peru or Nepal, for example. Hides and skins from home-slaughtered animals are rarely processed, as the returns may not justify the costs involved (Otte & Upton, 2005). Livestock acquisition as a pathway out of poverty has been documented by Kristjanson et al. (2004) in western Kenya, for example. Livestock provide traction mainly in irrigated, densely populated areas, and allow cropping in these places. They provide nutrients in the form of manure, a key resource particularly for the mixed systems of sub-Saharan Africa. Livestock also serve as financial instruments, by providing households with an alternative for storing savings or accumulated capital, and they can be sold and transformed into cash as needed and so also provide an instrument of liquidity, consumption smoothing and insurance. For some poorer households, livestock can provide a means of income diversification to help deal with times of stress.

In addition to their food security, human health, economic and e-environmental roles, livestock have important social and cultural roles. In many parts of Africa, social relationships are partly defined in relation to livestock, and the size of a household's livestock holding may confer considerable social importance on it. The sharing of livestock with others is often a means to create or strengthen social relationships, through their use as dowry or bride price, as allocations to other family members and as loans (Kitalyi et al., 2005). Social status in livestock-based communities is often associated with leadership and access to (and authority over) natural, physical and financial resources.

Livestock may have considerable cultural value in developed countries also. Local breeds have often been the drivers of specific physical landscapes (e.g. extensive pig farming in the Mediterranean oak forests of the Iberian Peninsula); as such, local breeds can be seen as critical elements of cultural networks (Gandini & Villa, 2003).

Compared with the biophysical environment, the social and cultural contexts of livestock and livestock production are probably not that well understood, but these contexts are changing markedly in some places. External pressures are being brought to bear on traditional open-access grazing lands in southern Kenya, for example, such as increasing population density and increasing livestock–wildlife competition for scarce resources. At the same time, many Maasai feel that there is no option but to go along with subdivision, a process that is already well under way in many parts of the region, because they see it as the only way in which they can gain secure tenure of their land and water, even though they themselves are well aware that

subdivision is likely to harm their long-term interests and wellbeing (Reid et al., 2008). There are thus considerable pressures on Maasai communities and societies, as many households become more connected to the cash economy, access to key grazing resources becomes increasingly problematic and cultural and kinship networks that have supported them in the past increasingly feel the strain. Inevitably, the cultural and social roles of livestock will continue to change, and many of the resultant impacts on livelihoods and food security may not be positive.

Social and cultural changes are likewise taking place elsewhere. In European agriculture, there is already heightened emphasis on, and economic support for, the production of ecosystems goods and services, and this will undoubtedly increase in the future (Deuffic & Candau, 2006). In the uplands of the UK, recent social changes have seen increasing demand for leisure provision and access to rural areas. At the same time, there are increasing pressures on the social functions and networks associated with the traditional farming systems of these areas, which have high cultural heritage value and considerable potential to supply the public goods that society is likely to demand in the future (Burton et al., 2005).

(d) Ethical concerns as a driver of change

Ethical concerns may play an increasing role in affecting the production and consumption of livestock products. Recent high-profile calls to flock to the banner of global vegetarianism, backed by exaggerated claims of livestock's role in anthropogenic global greenhouse gas emissions, serve mostly to highlight the need for rigorous analysis and credible numbers that can help inform public debate about these issues: there is much work to do in this area.

But science has already had a considerable impact on some ethical issues. Research into animal behaviour has provided evidence of animals' motivations and their mental capacities, which by extension provides strong support for the notion of animal sentience (i.e. animals' capacity to sense and feel), which in turn has provided the basis for EU and UK legislation that enshrines the concept of animal sentience in law (Lawrence, 2009). Recently, European government strategies are tending to move away from legislation as the major mechanism for fostering animal welfare improvements to a greater concentration on collective action on behalf of all parties with interests in animal welfare, including consumers (Lawrence, 2008). There is conflicting evidence as to the potential for adding value to animal products through higher welfare standards. There are common questions regarding the robustness of consumers'

preferences regarding welfare-branded, organic and local food, for example, particularly in times of considerable economic uncertainty.

While there are differences between different countries in relation to animal welfare legislation, animal welfare is an increasingly global concern. Part of this probably arises as a result of the forces of globalization and international trade, but in many developing countries the roots of animal welfare may be different and relate more to the value that livestock have to different societies: the sole or major source of livelihood (in some marginal environments in SSA, for example), the organizing principle of society and culture (the Maasai, for instance), investment and insurance vehicles and sources of food, traction and manure, for example (Kitalyi et al., 2005).

Improving animal welfare need not penalize business returns and indeed may increase profits. For instance (and as noted above), measurements of functional traits indicate that focusing on breeding dairy cows for milk yield alone is unfavourably correlated with reductions in fertility and health traits (Lawrence et al., 2004). The most profitable bulls are those that produce daughters that yield rather less milk but are healthier and longer lived: the costs of producing less milk can be more than matched by the benefits of decreased health costs and a lower herd replacement rate. Identifying situations where animal welfare can be increased along with profits, and quantifying these trade-offs, requires integrated assessment frameworks that can handle the various and often complex inter-relationships between animal welfare, management and performance (Lawrence & Stott, 2009).

(e) Wildcard drivers of change

There is considerable uncertainty related to technological development and to social and cultural change. This section briefly outlines an arbitrary selection of wildcards, developments that could have enormous implications for the livestock sector globally, either negatively (highly disruptive) or positively (highly beneficial).

(i) Artificial meat (more correctly, in vitro meat**)**

From a technological point of view, this may not be a wildcard at all, as its development is generally held to be perfectly feasible (Cuhls, 2008), and indeed research projects on it have been running for a decade already. There are likely to be some issues associated with social acceptability, although presumably meat ‘grown in vats’ could be made healthier by changing its composition and made much more hygienic than traditional meat, as it would be cultured in

sterile conditions. *In vitro* meat could potentially bypass many of the public health issues that are currently associated with livestock-based meat. The development and uptake of *in vitro* meat on a large scale would unquestionably be hugely disruptive to the traditional livestock sector. It would raise critical issues regarding livestock keeping and livelihoods of the resource-poor in many developing countries, for example. On the other hand, massive reductions in livestock numbers could contribute substantially to the reduction of greenhouse gases, although the net effects would depend on the resources needed to produce *in vitro* meat. There are many issues that would need to be considered, including the effects on rangelands of substantial decreases in the number of domesticated grazing animals, and some of the environmental and socio-cultural impacts would not be positive. There could also be impacts on the amenity value of landscapes with no livestock in some places. Commercial *in vitro* meat production is not likely to happen any time soon, however: at least another decade of research is needed, and then there will still be the challenges of scale and cost to be overcome.

(ii) Nanotechnology

This refers to an extremely dynamic field of research and application associated with particles of 1–100 nm in size (the size range of many molecules). Some particles of this size have peculiar physical and chemical properties, and it is such peculiarities that nanotechnology seeks to exploit. Nanotechnology is a highly diverse field, and includes extensions of conventional device physics, completely new approaches based upon molecular self-assembly and the development of new materials with nanoscale dimensions. There is even speculation as to whether matter can be directly controlled at the atomic scale. Some food and nutrition products containing nanoscale additives are already commercially available, and nanotechnology is in widespread use in advanced agrichemicals and agrichemical application systems (Brunori et al., 2008). The next few decades may well see nanotechnology applied to various areas in animal management. Nanosized, multipurpose sensors are already being developed that can report on the physiological status of animals, and advances can be expected in drug delivery methods using nanotubes and other nanoparticles that can be precisely targeted. Nanoparticles may be able to affect nutrient uptake and induce more efficient utilization of nutrients for milk production, for example. One possible approach to animal waste management involves adding nanoparticles to manure to enhance biogas production from anaerobic digesters or to reduce odours (Scott, 2006). There are, however, considerable uncertainties concerning the possible human health and environmental impacts of nanoparticles and these risks will have to be addressed by regulation and legislation: at present, for all practical purposes, nanotechnology is unregulated (Speiser, 2008). Brunori et al. (2008) see nanotechnology as potentially a highly

disruptive driver, and the ongoing debate as to the pros and cons is currently not well informed by objective information on the risks involved: much more information is required on its long-term impacts. Nanotechnology could redefine the entire notion of agriculture and many other human activities (Cuhls, 2008).

(iii) Deepening social concerns about specific technology

Much evidence points to a serious disconnect between science and public perceptions. Marked distrust of science is a recurring theme in polls of public perceptions of nuclear energy, genetic modification and, spectacularly, anthropogenic global warming. One of several key reasons for this distrust is a lack of credible, transparent and well-communicated risk analyses associated with many of the highly technological issues of the day. This lack was noted above in relation to nanotechnology, but it applies in many other areas as well. The tools of science will be critical for bringing about food security and wellbeing for a global population of more than nine billion people in 2050 in the face of enormous technological, climatic and social challenges. Technology is necessary for the radical redirection of global food systems that many believe is inevitable, but technology alone is not sufficient: the context has to be provided whereby technology can build knowledge, networks and capacity (Kiers et al. 2008). One area where there are numerous potential applications to agriculture is the use of transgenic methodology to develop new or altered strains of livestock. These applications include '… improved milk production and composition, increased growth rate, improved feed usage, improved carcass composition, increased disease resistance, enhanced reproductive performance, and increased prolificacy' (Wheeler, 2007). Social concerns could seriously jeopardize even the judicious application of such new science and technology in providing enormous economic, environmental and social benefits. If this is to be avoided, technology innovation has to take fully into account the health and environmental risks to which new technology may give rise. Serious and rapid attention needs to be given to risk analysis and communications policy.

Several assessments agree that increases in the demand for livestock products, driven largely by human population growth, income growth and urbanization, will continue for the next three decades at least. Globally, increases in livestock productivity in the recent past have been driven mostly by animal science and technology, and scientific and technological developments in breeding, nutrition and animal health will continue to contribute to increasing potential production and further efficiency and genetic gains. Demand for livestock products in the future, particularly in developed countries, could be heavily moderated by socio-economic factors such as human health concerns and changing socio-cultural values.

In the future, livestock production is likely to be increasingly characterized by differences between developed and developing countries, and between highly intensive production systems on the one hand and smallholder and agropastoral systems on the other. How the various driving forces will play out in different regions of the world in the coming decades is highly uncertain, however. Of the many uncertainties, two seem over-arching. First, can future demand for livestock products be met through sustainable intensification in a carbon-constrained economy? Some indications have been given above of the increasing pressures on natural resources such as water and land; the increasing demand for livestock products will give rise to considerable competition for land between food and feed production; increasing industrialization of livestock production may lead to challenging problems of pollution of air and water; the biggest impacts of climate change are going to be seen in livestock and mixed systems in developing countries where people are already highly vulnerable; the need to adapt to climate change and to mitigate greenhouse emissions will undoubtedly add to the costs of production in different places; and the projected growth in biofuels may have substantial additional impacts on competition for land and on food security.

A second over-arching uncertainty is, will future livestock production have poverty alleviation benefits? The industrialization of livestock production in many parts of the world, both developed and developing, is either complete or continuing apace. The increasing demand for livestock products continues to be a key opportunity for poverty reduction and economic growth, although the evidence of the last 10 years suggests that only a few countries have taken advantage of this opportunity effectively (Dijkman, 2009). Gura (2008) reported many cases where the poor have been disadvantaged by the industrialization of livestock production in developing countries, as well as highlighting the problems and inadequacies of commercial, industrial breeding lines, once all the functions of local breeds are genuinely taken into account. The future role of smallholders in global food production and food security in the coming decades is unclear. Smallholders currently are critical to food security for the vast majority of the poor, and this role is not likely to change significantly in the future, particularly in SSA. But increasing industrialization of livestock production may mean that smallholders continue to miss out on the undoubted opportunities that exist. There are numerous suggestions on ways to promote the development of sustainable and profitable smallholder livestock production, most specifically relating to significant and sustained innovation in national and global livestock systems (Dijkman, 2009); increasing regulation to govern contracts along food commodity chains, including acceptance and guarantee of collective rights and community control (Gura,

2008); and building social protection and strengthening links to urban areas (Wiggins, 2009). Probably all of these things are needed, headed by massive investment, particularly in Africa (World Bank, 2009).

It is thought that humankind's association with domesticated animals goes back to around 10 000 BC, a history just about as long as our association with domesticated plants. What is in store for this association during the coming century is far from clear, although it is suffering stress and upheaval on several areas. The global livestock sector may well undergo radical change in the future, but the association is still critical to the wellbeing of millions, possibly billions, of people: in many developing countries, at this stage in history, it has no known, viable substitute.

2.3 History and Origin of Swine Production

The pig dates back 40 million years to fossils which indicate that wild pig-like animals roamed forests and swamps in Europe and Asia. By 4900 B.C. pigs were domesticated in China, and were being raised in Europe by 1500 B.C. On the insistence of Queen Isabella, Christopher Columbus took eight pigs on his voyage to Cuba in 1493. But it is Hernando de Soto who could be dubbed "the father of the American pork industry." He landed with America's first 13 pigs at Tampa Bay, Florida in 1539. Native Americans reportedly became very fond of the taste of pork, resulting in some of the worst attacks on the de Soto expedition. By the time of de Soto's death three years later, his pig herd had grown to 700 head, not including the ones his troops had consumed, those that ran away and became wild pigs (and the ancestors of today's feral pigs or razorbacks), and those given to the Native Americans to keep the peace. The pork industry in America had begun. Pig production spread throughout the new colonies. Hernando Cortez introduced hogs to New Mexico in 1600, and Sir Walter Raleigh brought sows to Jamestown Colony in 1607. Semi-wild pigs conducted such rampages in New York colonists' grain fields that every owned pig 14 inches high had to have a ring in its nose. On Manhattan Island, a long solid wall was constructed on the northern edge of the colony to control roaming herds of pigs. This area is now known as Wall Street. The pig population of Pennsylvania colony numbered in the thousands by 1660. As the seventeenth century closed, the typical farmer owned four or five pigs, supplying salt pork and bacon for his table with surpluses sold as barreled pork. Finishing pigs on Native Americans corn became popular after becoming a common practice in Pennsylvania.

After the Revolutionary war, pioneers began heading west and they took their indispensable pigs with them. A wooden crate filled with young pigs was often hung from the axles of prairie

schooners. As western herds grew, the need for pork processing facilities became apparent. Packing plants began to spring up in major cities. Pigs were first commercially slaughtered in Cincinnati, which became known as Porkopolis. More pork was packed there than any other place in the mid-west.

Swine have been part of most human cultures since even before they were first domesticated Archeological records indicate that their earliest domestication was underway in southwest Asia far back 9000 years ago. By 6,000 to 7,000 years ago, swine domestication had spread into ancient Syria, Sudan, and Egypt, and then westward into Greece. It later spread to Western Europe. Archeological evidence also indicates that swine have been domesticated in China for 7000 years (Porter, 1993). Most early civilizations have included pork (which is a product of swine) in their diets since the domestication of it, except those who did not based on religion beliefs.

Swine have a well-defined role in the animal kingdom. Paleontology evidence indicates that swine originated about 40 million years ago and were present in Europe, Asia, and Africa. Their wide geographic distribution at these early stages of their evolution was associated with wide variation in their food supply, the climatic environment, and their general characteristics. Presently existing wide swine of Africa (bush pig, giant forest pig, warthog), Asia (babirusa, bearded pig, Javanese warty pig, Sulawesi warty pig), and Europe (Eurasian wild boar) resemble their early ancestors of a millennium or longer ago (Town & Wentworth, 1950; Mellen, 1952; Porter, 1993). Many of the wild pigs roaming in many parts of United States were likely introduced by early explorers and settlers.

The domestication of swine dated back to 6,000 to 8,000 BC. Archaeological evidence suggests that pigs were domesticated from wild boars as early as 13,00 – 12,700 BC in the Near East in the Tigris Basin (Sarah, 1998) being managed in the wild in a way similar to the way they are managed by some modern New Guineans (Rosenberg et al., 1998). Remains of pigs have been dated to earlier than 11,400 BC in Cyprus that must have been introduced from the mainland, which suggests domestication in the adjacent mainland by then. There was also a separate domestication in China which took place about 8000 years ago.

DNA evidence from sub-fossil remains of teeth and jawbones of Neolithic pigs shows that the first domestic pigs in Europe had been brought from the Near East. This stimulated the domestication of local European wild boars resulting in a third domestication event with the

Near Eastern genes ceasing in European pig stock. Modern domesticated pigs have involved complex exchanges with European domesticated lines being exported in turn to the ancient Near East. Historical records indicate that Asian pigs were introduced into Europe during the 18th and early 19th century (Giuffra et al., 2000). The adaptable nature and omnivorous diet of the wild boar allowed early humans to domesticate it readily. Pigs were mostly used for food, but early civilizations also used pigs' hides for shields, bones for tools and weapons, and bristles for brushes. In India, pigs have been domesticated for long time mostly in Goa and some rural areas for pig toilets.

The domestication started with the European wild boar and the Chinese pigs. The history of swine in the USA started with the Vikings from Scandinavia in 1000BC. In 1493 BC, Christopher Columbus entered Puerto Rico with 8 pigs. Then in 1519 BC Hernando Cortex brought in some pigs to Central America, precisely Mexico. In 1539 BC, Hernando de Sota brought in to Florida 13 sows and in the next three years he trekked to Mississippi River with some sows. Sir Walter Raleigh in 1611 BC travelled to Jamestown with some pigs and in 1620 BC, pilgrims invaded New England with pigs. Some few years latter there was influx of pigs from England to the USA. During this period, the pigs roamed freely, consumed plants, acorns, and even split rail fences wouldn't hold them in or out of the street. So, they became nuisance. Laws were established and stone walls were built on Manhanttan Wall Street (Giuffra et al., 2000).

2.3.1 Swine in the mid 1800's

The domestication of *sus scrofa* may have occurred as early as 10,000 B.C. in Southeast Asia (Lekagul & McNeely, 1977). Swine production was common in early agricultural societies, perhaps because swine are highly resilient, mature quickly, have large litters and are able to sustain themselves on low-quality feedstuffs. Swine were introduced into North Americaby many of the early explorers and settlers, but pork production began to florish in the USA after the practice of finishing swine on corn became established in the late 1600s (McGlone & Pond, 2003). This practice was so successful that, by 1847, there were nearly twice as many swine as people in the USA (35 million swine versus 20 million people) and Cincinnati was the largest pork market in the world (USDA, 1981). For most of the period after 1850, but particularly between 1890 and the present, the total number of swine in the USA has remained between 50 and 60 million animals (USDA, 2008). But beginning about 1900 in the USA, and more recently in other parts of the world, the total number of swine farms has been declining, resulting in fewer farms with more swine per farm (USDA, 2008).

The 1800s saw growth of swine production in the western part of America. Swine was first purchased in the Louisiana province in 1803. The government provided a piece of land to some individuals so they could settle there and develop a farm to rear swine. Swine got to the Erie canal in 1827. The major centers noticeable then were Ohio, Kentucky, and Tennessee. The first major packing plant was built in Cincinnati, Ohio and became known as 'porkopolis'. The same period saw the introduction of American breeds and railroad system including refrigerated rail cars. Cincinnati, Ohio became the center of pork processing, where local swine were slaughtered and shipped over the Appalachin Mountains to the large population centers along the East Coast. Salted, cured, and pickled pork allowed for transport over long distances to the east, making swine the preferred livestock for long-distance marketing (USDA, 2008).

The Corn Belt grew to the west through Indiana, Iowa, Missouri, southern Minnesota, southern Michigan, southern Wisconsin, and into eastern Kansas and eastern Nebraska. Rich, fertile soil, an abundance of rainfall, and more open plains resulted in a massive development farmlands. The production of corn and cereal grains-the crop of choice-soon far exceeded the needs of human consumption, and the swine proved to be an efficient converter of these feed resources to meat for human consumption. The swine soon became known as the "mortgage lifter" in Midwest agriculture and the region was soon referred to as the "corn belt," where grain production is greater than that of any other region of the United States.

History had it that swine was popular in early Americans because of the following:

- Hardy
- Prolific
- Did well on the new crop (corn) introduced by the Indians
- Meat was easily preserved ie was easily cured, smoked, or canned
- Excellent source of fat (lard); high caloric diet was needed, lard was used for cooking, candles, and soap
- Valuable export e.g. Salted pork.

2.3.2 Swine Production in Modern time.

Before the mass production and re-engineering of pork in the 20th century, pork in Europe and North America was traditionally an autumn dish – swine and other livestock coming to the slaughter in the autumn after growing in the spring and fattening during the summer. During the 1980s to 1990s, major technological advancements allowed pork production to grow in

states previously not known for it. The most notable growth has been in North Carolina, which now holds the spot as the second largest pork producing state.

Larger, more efficient operations started replacing the small family farm that could no longer produce swine profitable and the modern pork industry was born. While the number of operations has decreased, the number of animals has not. The modern method for the majority of pork production occurs in enclosed buildings to protect animals from the weather, predators, and the spread of diseases while reducing the land needed to accommodate a large number of animals. Although this method enables farmers to significantly increase production efficiency while reducing labour, it has resulted in environmental challenges by producing larger and more concentrated amount of animal waste.

Swine today are bred to be leaner than swine of earlier times. Currently, swine contain 50 percent less fat than swine of the 1950s. The leaner swine is a direct result of technology of hog production as well as superior genetics. Pork production in the United States is a vital part of the economy. Nearly 19 billion pounds of pork were processed from about 97 million hogs in 2001. The economic impact of the industry on rural America is immense. Annual farm sales typically exceed $11 billion, while the retail value of pork sold to consumers reaches $38 billion each year. Pork also provides employment well beyond the farm. The U.S. pork industry is responsible for more than $72 billion in total domestic economic activity. In addition, the pork industry supports more than 800,000 jobs and adds more than $27 billion of value to basic production inputs such as corn and soybeans. There are approximately 85,760 pork operations today compared with nearly three million in the 1950s. Farms have grown in size, nearly 80 percent of the hogs are grown in the farms, which produce 5,000 or more hogs per year. This move to modern production practices is a direct result of consumer demands for a lower or stable cost while still expecting a higher quality product from the pork industry. The cost of pork has moved very little in the past 50 years, while input costs for the producer has increased significantly.

There are tremendous improvements in the modern swine farms today compared with the early days. While the early days saw the swine roaming freely, extremely fat, foraged on roots, and berries and herded in droves to the market, today the scenario have changed. Modern swine are totally confined in slatted floors in environmentally controlled buildings. They are fed with automated machines, a good waste management scheme and a very high level biosecurity. Modern technology has made it possible for different breeds of swine through crossbreeding

system. Artificial insemination has increased the number of productions yearly. Farrowing is a continuous process and early weaning has become common in the farms.

2.4 Swine Behaviour

The behavior of domestic swine is more like that of dogs and humans, rather than cattle or sheep, in many ways; their behavior appears to be intermediate between that of carnivores and the more highly evolved artiodactyls (Clutton-Brock, 1987). Domestic swine seek out the company of each other and often huddle to maintain physical contact, although they do not naturally form large herds. A behavioural character of domestic swine which they share with carnivores is nest building and bed making (although modern production system often prevents these). Swine root (digging with the nose or snout) out wallows or depressions and the females will build nests in which to give birth. First, she digs a depression about the size of her body. She then collects twigs, grasses and leaves, and carries these in her mouth to the depression, building them into a mound. She digs smaller, finer material to the center of the mound using her feet. When the mound reaches the desired height, she places large branches, up to 2 meters in length, on the surface. She enters into the mound and roots around to create a depression within the gathered material. She then gives birth in a lying position, which again is different from other artiodactyls which usually give birth in a standing position.

Domestic piglets are highly precocious and within minutes, or sometimes seconds, will attempt to suckle. The piglets fight to develop a teat order as the anterior teats produce a greater quantity of milk. Once established, this teat order remains stable with each piglet tending to feed from a particular teat or group of teats.

If conditions permit, domesticated swine feed continuously for many hours and then sleep for many hours, in contrast to ruminants which tend to feed for a short time and then sleep for a short time. Swine are omnivores and are highly versatile in their feeding behavior. They can survive well by scavenging on the same types of foods that humans and dogs can live on. In the wild, they are foraging animals, primarily eating leaves, grasses, roots, fruits and flowers. Domestic swine are intelligent (Broom et al., 2009), and can be trained to perform numerous tasks and tricks (Angier, 2009). Recently, they have enjoyed a measure of popularity as house pets, particularly the dwarf breeds.

Very rarely, either naturally, as a result of unusually aggressive behavior, or perhaps as the result of a pathological process which alters their disposition, domestic farm-based swine have become aggressive and injured and eaten their handlers.

Swine are social animals. From an evolutionary perspective, being social conveys a number of benefits, but potentially some disadvantages, especially for certain individuals within the group. Living in a social group can reduce predation, improve successful foraging, improve rearing of offspring, increase chances of mating and help in heat regulation. The major social behaviors of swine are those behaviors that relate to formation and maintenance of social organization, namely those centered on aggression and social dominance.

In order to better understand the consequences of the systems in which we place swine during commercial production, it is crucial to acknowledge the swine's origins and social behavior in a natural setting. The domestic swine is descended from the wild boar, but although they have changed greatly in terms of phenotype, their behavior, when given opportunity, is extremely similar to their wild ancestors. Their natural social organization centers on a core group of 2-4 related sows plus their associated offspring of different sizes and ages. Sows in this group are likely to live like a family. Group size will be influenced by habitat and resource availability, especially food, and also the home range. Sometimes home range may overlap with another group, the groups try to avoid open confrontation with each other. As the offspring mature, the females split off to form their own group, while the males split off to form adolescent bachelor group, becoming solitary as mature boars. Within group, aggression is very rare. The group usually maintains a simple, linear social hierarchy, which is relatively stable over time. Position within the hierarchy is mostly determined by size and age, with large, mature physically strong sows being dominant over the smaller ones. Aggression does occur during competition for food, but most often the younger ones actively avoid conflict with the older ones. This social organization is such that swine are not exposed to unrelated, unfamiliar swine. This social behavior is common with swine in their natural habitat (Angier, 2009).

In contrast, swine housed in commercial systems may be housed individually in close proximity to others or in groups ranging from small to large. Regardless of group size, there will be relatively limited space and a relatively simple environment and they may encounter frequent remixing. Access to food may be restricted. Under commercial condition, aggression seems to be more prevalent than under natural condition.

Aggressions occur when unacquainted swine are mixed together. This always led to fight. The fight does not often break out immediately but can be a complex and gradual event as swine investigate each other using a specific and often reciprocal behaviors such as nosing, sniffing and nudging. This may then escalate into more vigorous pushing and pressing, bites, head-knocks and mounting, which continue until one withdraws. The hierarchy is then maintained by threats, avoidance and withdrawal, or short-lived aggressive interactions.

Another area of social behaviour in swine is the feeding aspect: Swine naturally tend to synchronize feeding and actively forage for relatively low-quality food for many hours during the day, with peaks in activity around dawn and dusk. This behavior is seen among wild swine in their natural state. This is very different from the commercial situation. In production, swine will have access to high quality feed, which can meet their nutritional requirements quickly and it may only be available for an extremely limited period of time each day. Whereas the grow/finish herd may have free access to food but with restricted number of feeding spaces, the breeding herd usually has access to a single food drop a day. In many intensive production systems, swine do not have access to any alternative foraging substrate, such as straw, and thus, access to food becomes an important resource and one that may play a major role in determining the amount of aggression being displayed within a system. For sows, feeding systems that promote competition for access, such as floor feeding, can have relatively high level of aggression. Feeding systems that reduce competition by enclosing sows in stalls or being available freely can have relatively low aggression. Floor feeding may be cheap and low technology in terms of equipment, but it is highly competitive with dominant sows able to monopolize the feed if it is not widely distributed. In most cases it becomes the survival of the fittest.

2.5 Swine Distribution around the World

Swine production is widely scattered across the globe. The estimated global swine inventory of over 801 million in 2002 was a slight increase over the global swine inventory estimate of over 782 million in 1996. The countries of Asia have the largest inventory of swine in the world, accounting for over 62% of the total global inventor in 2002. The countries of European Union account for nearly 15% of the global inventory, followed by North America with approximately 10%. Swine are produced primarily in regions of the world with available natural resources including: arable land, cereal grains, and water (FAOSTAT, 2001).

The people Republic of China by a large margin have highest number of swine in the world, with an estimated inventory of 464 million pigs or approximately 58% of the global total. The Chinese swine production is predominantly produced and raised by a very large number of individual families having small herds consisting of only a few animals. This in contrast to many other countries of the world, where swine production is in the hands of small proportion of the population and production units is very large in size. The USA is the second largest swine producing country in the world, with an inventory of approximately 60 million pigs at any given point in time.

Table 2.4: Swine inventory (x 1000) is selected countries (1996 and 2000)

Region	*Countries*	1996	2002
	Canada	11,588	14,726
North America	Mexico	11,100	10,729
	USA	58,201	58,943
	Subtotal	80,889	84,398
South America	Brazil	32,068	32,735
European Union		114,009	120,900
	Bulgaria	2,140	1,100
	Czech Republic	4,024	4,120
Eastern Europe	Hungary	5,032	4,955
	Poland	20,343	19,000
	Romania	7,960	4,650
	Subtotal	39,499	33,825
Former Soviet Union	Russian Federation	22,630	17,000
	Ukraine	13,144	9,000
	Subtotal	35,774	26,173
	China, Peoples' Republic of	441,692	464,000
	Japan	9,900	9,550

Other Asia	Korea, Republic of	6,461	8,110
	Philippines	9,023	12,218
	Taiwan	10,510	7,000
	Subtotal	477,586	500,878
Oceania	Australia	2,600	2,729
	Total	782,425	801,465

Source: Foreign Agricultural Service, Commodity and Marketing Programs (2003) http://www.fas.usda.gov/psd/complete_files/LP-0013000.csv

Swine are found throughout the world, but their distribution is not uniform. Swine are found in great numbers in most of Asia, Europe, and North and South America. However, cultural and religious differences among regions of the world are partially responsible for differences in distribution patterns. Table 2.5 shows the amount of pig meat produced around the world in 2000, along with the human population and the amount of pork available per capita per year in each country or region, based on population in 1999 (FAOSTAT, 2001)

Table 2.5: Human population and pig meat production around the word, 2000.

COUNTRY OR REGION	HUMAN POPULATION(BILLIONS)	PIG MEAT PRODUCTION (T)	PIG MEAT/CAPITA/YEAR
Asia (ind. China and japan)	3.634	50,371,208	282
China	1.274	43,053,600	74.4
Africa	0.767	565,036	1.6
European Union	0.375	17,565,100	103.0
Eastern Europe	0.121	4,899,593	88.9
South America	0.341	2,962,215	19.1
Canada	0.031	1,675,000	119.1
Japan	0.127	1,270,000	22.1
Mexico	0.097	1,034,906	23.3
Republic of Korea	0.047	940,836	44.4
Russian federation	0.147	1,250,000	18.7
United State	0.276	8,532,000	68.0

World total	5.978	91,030,043	33.4

1999 FAOSTAT (2001) figures for human population

Table 2.6: World Meat and Milk Production in 1970 and 2000

AMOUNT PRODUCED		PERCENT INCREASE,	
SOURCE OF MEAT OR MILK		MT/YR (MILLIONS)	1970 TO 2000
	1970	2000	
Pig	35.8	91.0	254
Beef and veal	38.4	57.1	149
Chicken	13.1	56.9	434
Turkey	1.2	4.8	400
Sheep	5.5	7.6	138
Goat	1.3	3.7	285
	-	-	-
Total Meat	1004	233.2	233
Cow Milk	359.3	484.7	135

Source: FAOSTAT (2001).

On a worldwide basis, more pork is produced and eaten than any other meat (Table 2.6). In 2000, the world consumed 59% more than beef, its closest competitor. However, chicken consumption and production are rising rapidly in the United State and around the world. If the current trend continues, pork and chicken consumption will be equal by about the year 2020. However, food consumption patterns vary over time for reasons that include changes in economic status, political unrest, and many others.

Data from the largest pig producing countries show changes in herd size as a restructuring takes place. A global decrease of pig meat production in 2011 narrowed the gap between pork and poultry meat for global tonnage, but both still maintain a faster growth rate than beef.

Fundamental changes are shaping global pig production. Global pork production in 2011 dropped to 109 million metric tons of pig meat produced, according to the FAO (food and agriculture organization) (FAOSTAT, 2001) of the United Nations. Pig meat production is down from the same agency's preliminary figure of 110.2 million metric tons; it is also considerably below the 109.9 million metric tons of pork the FAO reported in 2010 (Chart 1).

An annual downturn in the total world volume would be unusual— it has happened only once before, in the past 11 years—although the percentage rate of expansion achieved during each decade has been declining since 1960.

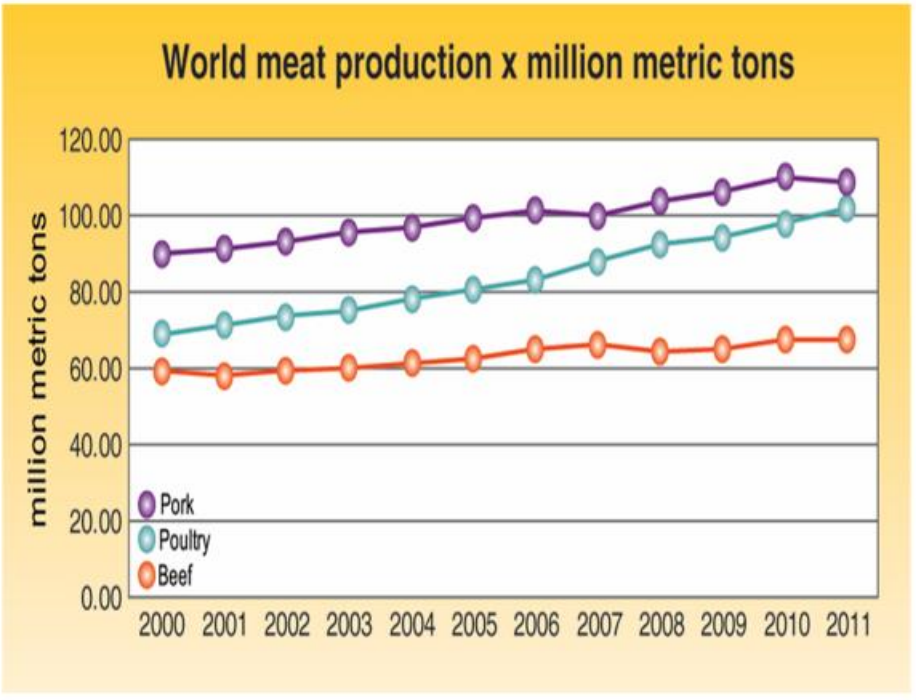


Chart 1: World meat production in 2011 (FAOSTAT, 2001).

As Chart 1 illustrates, the decrease in 2011 also narrowed the gap between pork and poultry meat for global tonnage, while both still maintain a faster growth rate than beef.

Asia-Pacific remains the largest region of the world for yearly pork production. In round terms, it supplied 57 percent of all output in 2011. By comparison, its share was more than double that from Europe, which provided twice the amount, produced in North America and this in turn was approximately double the quantity from Latin America.

But the 2011 world production estimate for pig meat should also be seen in the context of the major national producers. Table 1 shows the amounts recorded as having been produced in the 20 countries with the biggest annual tonnages. These countries account for 86 percent of the global pork total in 2011. Table 1data suggests that several countries even managed a modest growth in their own pork output. Nonetheless, the combined production of the Top 20 fell by 1.25 percent or around 1 million metric tons.

The figures in Table 1 underline how the overall result was affected by a drop in China's national pig production. Over three-quarters of the world's pig meat is supplied by China, the United States and the European Union (EU-27). Our lineup lists EU members individually. Together, the full 27-country community produced nearly 22.4 million metric tons of pork in 2011, up marginally from 22.01 million metric tons in 2010.

Judging by the three trends depicted in Chart 2, the EU seems to have made a recovery from the feed cost crisis of 2008 and 2009 while the US continued to enjoy the benefits of its increased pork exports. China, by contrast, experienced a reduction in 2011—attributed to the combined effects of low margins and increased disease problems.

The inventory of breeding sows in China is considered to have increased year-on-year by the end of 2011, as shown in Table 2. For the 30 countries listed, total sow numbers grew from about 84.4 million in 2010 to almost 86 million in 2011.

The danger would be in viewing this as an expansion, when it was evidently because of the return of the Chinese national breeding herd to the size it had reached in 2009 before disease forced a cutback. Take China out of the equation and the other 29 countries sow numbers dropped from 36.9 million to 36.7 million.

The following 20 countries account for 86 percent of global pork production in 2011.
A further reduction in sow inventory is predicted for the more mature markets worldwide as an adjustment to new circumstances, not least the continuing rise in herd productivity.
In the US, for example, an analysis by the FAPRI food policy unit at the University of Missouri pointed out that the US sow herd of 2011 was 20% smaller than 20 years ago—but output in 2012 is still expected to be 35 percent more than in 1992 because of the extra productivity obtained per sow.

In the European Union, a key consideration currently is the likely impact of new legislation demanding that pregnant sows be loose-housed instead of being confined in individual stalls. Most sources expect that older pig producers or farmers with small herds will decide to quit rather than undertake the expense of rebuilding. Forecasts start at 5 percent for the reduction in EU pork output that will occur because of the pending animal welfare law.
Chart 3 demonstrates how the number of sows in the EU-27 countries has fallen by 15 percent since 2004.

Legislation and financial considerations provide only part of the explanation for the reshaping of the global pork industries that is now occurring. Another factor proving to be especially potent is the response of local investors to the position of their home country in new or impending international trade agreements.

Russia's entry into the World Trade Organization has given an example, by leading to predictions that local pork production will struggle to compete with imports. The opposite of a positive response to a trade accord can be found in members of the ASEAN pact of Southeast Asia which expect a forthcoming wider Asian accord to benefit the pork industries in Thailand and Myanmar.

According to several expert observers, the element that is most influencing change in the pig industry profile is the rapid disappearance of backyard swine production in a number of developing nations. Average unit size keeps increasing even in developed countries. In Canada, the average number of pigs per farm increased by 31.5 percent between 2006 and 2011, on new calculations from Statistics Canada. But the departure of the backyard pig farmers under cost pressures since 2000 has been particularly marked in China. Although commercial pig producers are growing, their expansion has struggled to compensate for the loss of inventory in small-scale herds.

▼ TABLE 1: Trends in annual pork production (x 1000 tons) for the 20 countries ranked largest for annual volume in 2011

	Rank 2010	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1: China	1	41406	42982	44358	45186	47016	50106	48700	42878	46205	48905	51070	49500
2: USA	2	8597	8691	8929	9056	9312	9392	9559	9962	10599	10442	10186	10332
3: Germany	3	3982	4074	4110	4239	4308	4500	4662	4985	5114	5241	5443	5598
4: Spain	4	2912	2993	3070	3190	3076	3168	3235	3439	3484	3291	3369	3479
5: Brazil	5	2556	2730	2872	2560	2621	2710	2830	2990	3015	3130	3195	3227
6: France	8	2318	2315	2350	2333	2311	2274	2263	2281	2277	2004	2010	1998
7: Russia	7	1341	1287	1367	1481	1433	1334	1444	1640	1736	1844	1920	1995
8: Vietnam	6	990	1069	1209	1257	1408	1602	1713	1832	1850	1910	1930	1960
9: Poland	10	1892	1820	1981	2094	1923	1926	2071	2091	1888	1608	1741	1811
10: Canada	9	1640	1731	1854	1882	1936	1920	1898	1894	1786	1789	1772	1770
11: Denmark	11	1624	1714	1759	1762	1809	1793	1749	1802	1707	1583	1666	1718
12: Italy	12	1488	1510	1536	1589	1590	1515	1556	1603	1606	1588	1633	1570
13: Netherlands	14	1623	1433	1377	1253	1287	1297	1265	1290	1318	1275	1288	1347
14: Japan	13	1256	1232	1246	1260	1272	1245	1247	1251	1249	1310	1292	1267
15: Philippines	15	1008	1064	1332	1346	1376	1320	1371	1245	1190	1240	1255	1260
16: Mexico	16	1030	1058	1070	1035	1150	1195	1108	1152	1161	1162	1165	1182
17: Belgium	17	1055	1072	1044	1029	1032	1013	1006	1063	1056	1082	1124	1108
18: Taiwan	18	921	962	935	893	898	911	930	913	862	857	845	840
19: Korea Rep.	19	916	928	1005	1149	1105	1050	1091	1133	1056	1062	1110	837
20: UK	20	923	781	795	715	720	706	697	739	740	720	774	806

FAO analysts are predicting global pork production will rebound in 2012 to a new record of 111.7 million metric tons, an increase from 2011 by around 2.6 percent. The main influence is reckoned to be a reduced incidence of disease affecting Asian pig industries, but the agency has also identified growing policy support by a number of governments.

Add to that the return of some countries to the role of pork exporter. Mexico is an example in this instance after its official recognition as being free of classical swine fever (hog cholera), although Taiwan will be another to watch as it wins the battle against foot-and-mouth disease.

2.5.1 Swine Numbers in Each Country

In a given region or country, the amount of pork served in restaurants and homes may vary from none to an abundance, for ethnic or religious reasons. Muslim, Hindu, Jewish, and several other religions forbid pork consumption. Many ethnic groups in India and part of South Asia do not eat pork. However, peoples of central and northern parts of Asia produce more pork and eat more in total (not per capita) than peoples of any other region of the world. Latin Americans eat more pork than any other meat overall, but peoples of some countries (e.g., Argentina) eat beef in the largest amount. Nearly all pork produced in most countries is consumed locally. Notable exceptions are Taiwan and Denmark. On a per capita and historic basis, Taiwan

produces more pork than any other major Asian country. The high density in Taiwan creates a challenge, as in other countries such as Denmark and The Netherlands, in dealing with the high volume of manure.

In Denmark, as in Taiwan, a high proportion of the pork produced is exported, although, as in Taiwan, Denmark's per capita pork consumption is high. Denmark's major markets are United Kingdom and Asia, especially Japan.

Table 2.7 below highlights the pig meat production and consumption for the 15 member countries of the EU and for the USA, 1999.

Table 2.7: Pig meat Production and Consumption for the 15 EU Countries and USA, 1999

Population		Pig Meat Produced		Pig meat Consumed	
Country	(millions)	Tons.	Per capita (lb)	Tons.	Per capita(lb)
Austria	8,177	499,000	134	547,600	147
Bel/Luxembur g.	10,579	1,004,700	209	350,382	73
Denmark	5,282	1,641,800	684	336,416	140
Finland	5,165	181,860	77	176,427	75
France	58,886	2,377,000	89	2,220,788	83
Germany	82,178	3,979,800	107	4,576,973	123
Greece	10,626	138,300	29	295,597	61
Ireland	3,705	250,700	149	139,324	83
Italy	57,343	1,471,702	56	2,052,024	79
Netherlands	15,735	1,711,00	239	960,632	134
Portugal	9,873	349,601	78	403,773	90
Spain	39,634	2,893,000	160	2,371,381	131
Sweden	8,892	325,400	81	2,347,492	86
U.K.	58,974	1,047,000	39	1,526,129	57
TOTAL	375,039	17,860,863		16,204,899	
U.S.A	276,218	8,532,000	68	8,475,192	67

Source: FAOSTAT (2001).

2.5.2 History of Wild Swine in United State of America

Wild pigs (also known as wild hogs, wild boar, or feral swine) are an Old-World species and are not native to the Americas. The first wild pigs in the United States originated solely from domestic stock brought to North America by early European explorers and settlers. Many years later, Eurasian wild boar were introduced into parts of the United States for hunting purposes. In areas where domestic pigs and Eurasian wild boar were found together in the wild, interbreeding occurred. Today, many hybrid populations exist throughout the wild pig's range. Pigs were first introduced in the 1500's to what is now the southeastern U.S. by Spanish Explorer, Hernando DeSoto. In the centuries following European exploration and colonization of the eastern U.S., free-range livestock management practices and escapes from enclosures resulted in the establishment of wild pig populations and promoted their spread.

Eurasian Wild Boar

The Range of Wild Pigs Today

- Wild pigs have been reported in at least 45 states
- Populations now exist as far north as Michigan, North Dakota, and Oregon
- Range expansion over the last 20 years is mostly a result of illegal translocation of pigs by humans.

Distribution of Feral Pigs in the United States in 1988 (Courtesy of Southeastern Cooperative Wildlife Disease Study, University of Georgia)

Distribution of Feral Pigs in the United States in 2009 (Courtesy of Southeastern Cooperative Wildlife Disease Study, University of Georgia)

The Human Factor

Wild pigs awaiting transport to an undisclosed location.

The popularity of wild pigs as a game species has played a major role in the expansion of their range throughout the United States. The sudden presence of wild pigs in new areas is most often a result of

- escapes of stocked animals from privately owned, “game-proof” fenced hunting preserves
- illegal translocation: the practice of capturing wild pigs, transporting them to new locations, and releasing them into the wild

2.5.2.1 Swine Production in United State of America

Pork production is an important component of American agriculture and an important part of the American diet and way of life. Fewer than100,000 farms were producing pork in 2000 with production is concentrated in the Corn Belt states and in North Carolina.

Modern pork production is mostly done in enclosed buildings to protect animals from the weather, from predators and from the spread of diseases. While larger operations enabled farmers to significantly increase the efficiency of production using less labor, it resulted in environmental challenges with larger amounts of manure concentrated in a small area.

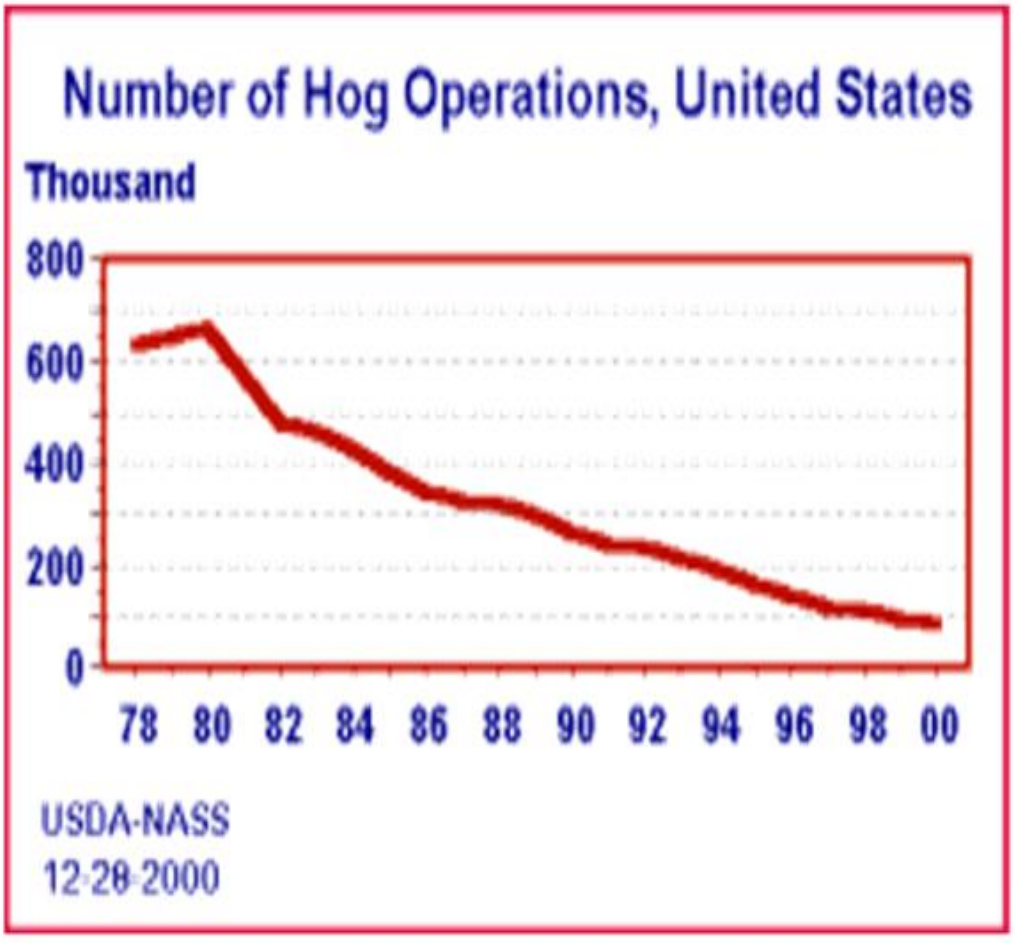
This module will look at pork production as it has evolved over the past 300 years in the U.S., at the economic value of pork to the U.S. and American agriculture and at typical production and manure handling systems in use today.

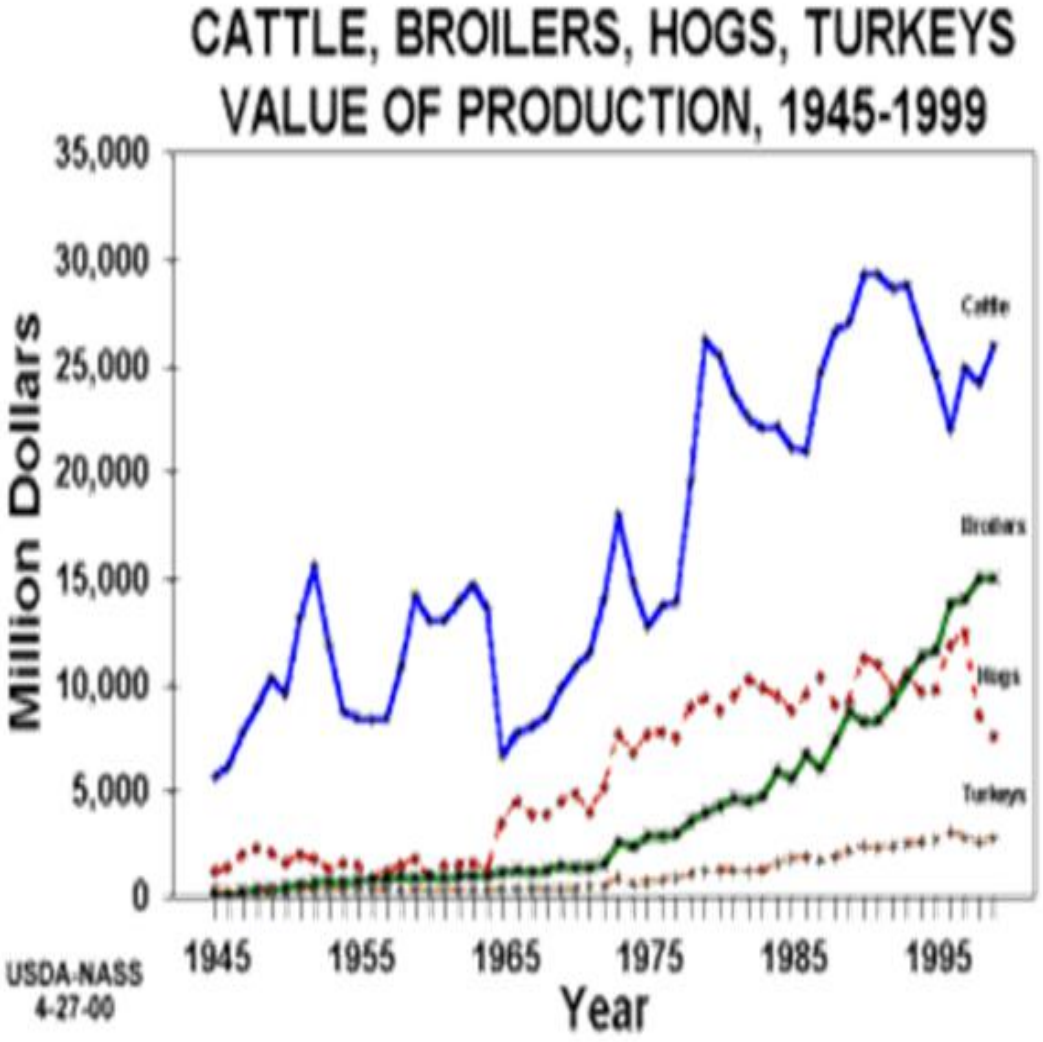
Wild boars domesticated in N. Europe c. 1500 B. C., are believed to be the ancestor of modern domesticated hogs, along with a genetic input from smaller Asian species domesticated in China around 3000 B.C. Pork, the meat from swine, was widely consumed throughout the ancient world and the Roman Empire. Pigs were not indigenous to the Americas, but came from Europe

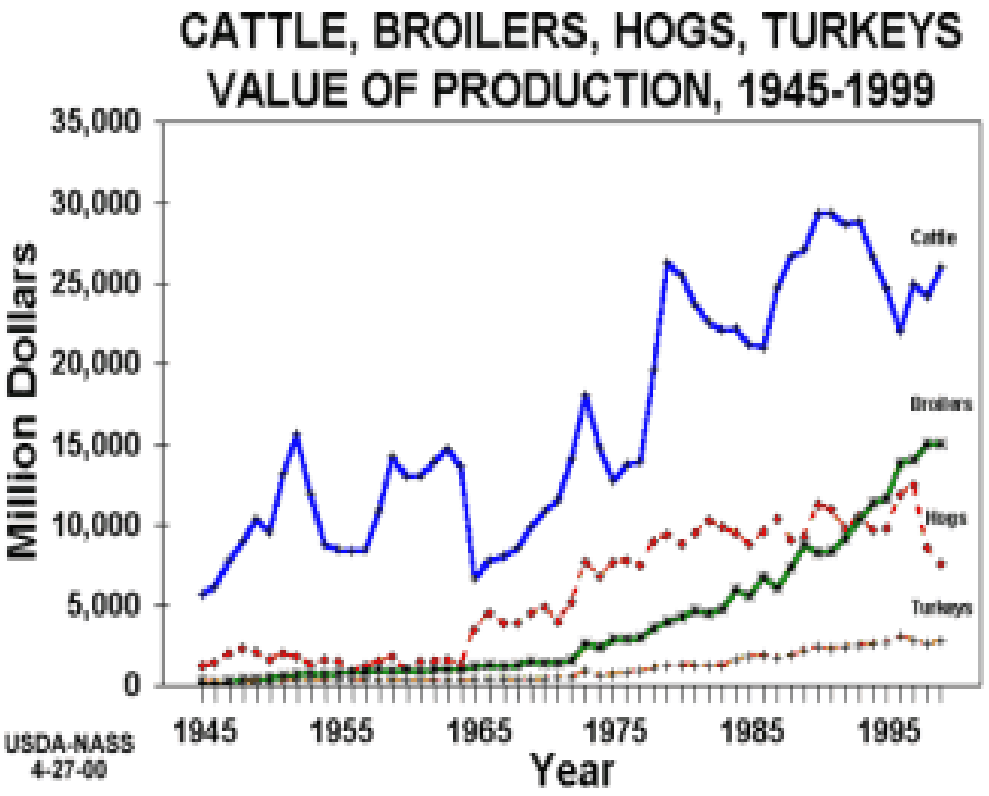
and the Orient. Columbus brought hogs on his second voyage to the Americas in 1493. Polynesians may have brought pigs from the Orient to the Hawaiian Islands even earlier.

For much of the 19th and 20th centuries, pork was the preferred meat in the U.S. Hogs were valued not just for their meat but for the lard, which was used for everything from cooking and lamp oil to baking and making candles and soap. As Americans became more health conscious, they lost much of their appetite for animal fats, switching to more healthy vegetable oils. Production began to focus on the pigs' ability to efficiently convert feed into protein, which resulted in a much leaner type of pig being produced.

There has also been a significant change in how and where hogs are produced in the U.S. over the past 50 years. Low consumer prices, and therefore low producer prices, have resulted in larger, more efficient operations, with many smaller farms no longer able to produce pigs profitably.







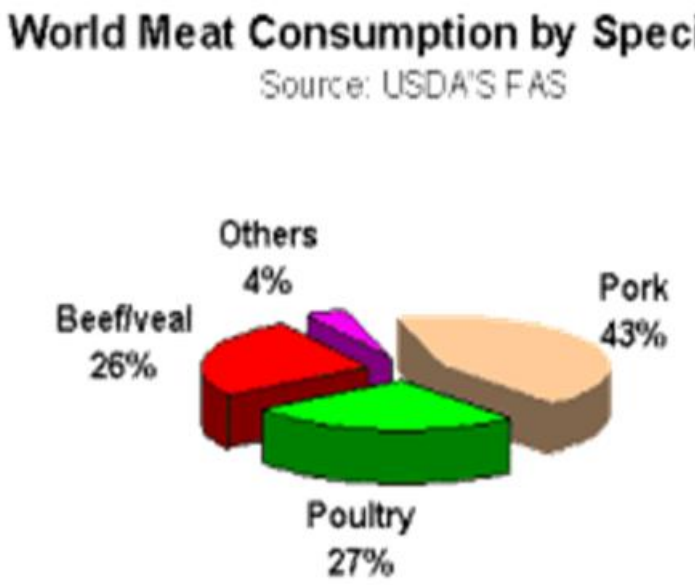
Source: USDA - NASS

In 1997, sales of all animals in the U.S. totaled over $75 billion. Currently, most of the swine in the United States are produced in North Carolina and the Midwestern and plains states, including Nebraska, Iowa, Minnesota, Missouri, Indiana and Illinois. Worldwide, China is by far the largest producer of pork, producing nearly four times as much as the U.S.

There are many breeds of swine, such as Hampshire, Duroc, Poland, China, Landrace, etc., but most farms use crossbreeds to try to gain the best traits of each breed.

Products from Pork

Pork is the most widely consumed meat in the world. People eat many different pork products, such as bacon, sausage, pork chops and ham. A 250-pound market hog yields about 150 pounds of pork.



Several valuable products or by-products, in addition to meat, come from swine. These include insulin for the regulation of diabetes; valves for human heart surgery; suede for shoes and clothing; and gelatin for many food and non-food uses. Swine by-products are also important parts of such products as water filters, insulation, rubber, antifreeze, certain plastics, floor waxes, crayons, chalk, adhesives and fertilizer.

Pork Production Phases

Breeding-Gestation

Farrowing

Nursery Pigs

Grow-Finishing

The phases of pork production that take place on the farm to produce hogs ready for market are called: breeding-gestation, farrowing, nursery and grow-finish.

Breeding-Gestation

Swine production can be logically separated into a number of phases, beginning with the sow being bred. Historically, this has been done by placing a number of sows in a pen with one or more boars. In confinement buildings, boars are often rotated between sow pens to make sure that all sows are bred while they were in heat. Sows in enclosed shelters come into estrous, 3 until 5 days after their pigs are weaned. The estrous period, or standing heat, is the period when the sow can be bred. Estrous only lasts a short time, so it is critical that the sow is bred at this time. During estrous, the sow shows outward signs of being willing to accept the boar, such as standing still when the producer applies downward pressure on her back or holding her ears erect. If the sow is not bred during this period, she normally returns to estrous about 21 days later. These two periods are known as "first heat breeding" and "second heat breeding". The non-pregnant sow is considered "unproductive" during this 3-week period, since she still must be fed and housed. Most modern operations have sows bred only on first heat. Sows that fail to breed during this estrous are often sent to market and replaced in the sow herd by gilts, or young females that are removed from the grow-finish group of pigs. After breeding, the sow "gestates" her "litter" for 113 to 116 days before the pigs are born or "farrowed." A good way

to remember gestation length for swine is that it is approximately "3 months, 3 weeks and 3 days".

Farrowing

Protecting piglets in a farrowing crate (Source: Purdue University)

Pen farrowing (Source: USDA)

Just before giving birth, called farrowing, sows are normally moved into a "farrowing room." Sows typically farrow from eight to twelve piglets, which as a group are called a litter. Most confinement operations place the sow in a temperature-controlled environment and usually in a farrowing pen or crate which restricts her movement to protect her baby pigs. The baby pigs spend most of their time in a "creep area on one or both sides of the crate where they have

ready access to their mother, but are protected from crushing when she lies down. A few farrowing operations in the U.S. use larger pens and provide deep straw bedding on solid floors. While this is a more natural process for the sow, it involves more labor and often results in higher crushing losses.

An average sow will raise three to five litters of pigs in her lifetime. Sows may be culled and sent to market, because of age, health problems, failure to conceive, or if they are able to raise only a low number of pigs per litter.

Pigs are born with eight needle-sharp teeth and curly tails. The tips of the teeth are clipped at birth to prevent injury to the sow's utter and other piglets and the tail is shortened to prevent tail biting. Piglets weigh about three pounds at birth and are weaned from the sow at anywhere from five days to four weeks, with most operations weaning pigs at two to three weeks.

Nursery Pigs

Source: Purdue University

After weaning, pigs are normally placed in a "nursery" where they are kept in a temperature-controlled environment, usually on slotted floors. The floors in a nursery are usually constructed from plastic or plastic covered steel instead of concrete to provide additional comfort for the small pigs. Pigs are normally given around three square feet of space each and provided with ready access to water and feed. Nursery pens are sometimes elevated, with their slotted floor above the room floor level 8 to 12 inches. This is done to minimize the possibility of cold floor drafts chilling the young pigs. Immediately after weaning, the temperature in the nursery may be as much as 85 degrees, and then dropped gradually to about 70 degrees as the pigs grow. Pigs are normally removed from the nursery at about 6 to 10 weeks of age and placed in a "grow-finishing" building. Nursery rooms are almost always heated with furnaces and ventilated with mechanical fans, controlled by a thermostat, in order to keep the pigs warm and dry throughout the year.

Grow-Finishing

This phase is where pigs are fed as much as they wish to eat until they reach market weight of 250 to 275 pounds and provided around 8 sq. ft. of space per pig. Marketing normally occurs at five to six months of age, depending on genetics and any disease problems encountered. Some gilts are returned from the grow-finish phase to the sow herd for breeding purposes, to replace older sows that are culled.

Grow-finish pig on concrete slotted floor (Source: Purdue University)

Naturally Ventilated (Grow-finish building)

Mechanical ventilation in grow-finish building (Source: Purdue University)

Animals in a grow-finish operation are larger and produce a great deal of body heat. Ventilation to keep the animals cool is usually more of a concern than providing heat in winter. Animals at this age grow best at around 60-70 degrees. In winter, they are protected from winter winds in a moderately well insulated building. Enough ventilation must be provided to remove moisture and to provide fresh air for the animals. In summer, large sidewall vents are opened or large ventilation fans are operated to keep the animals comfortable. This is referred to, respectively,

as naturally ventilated (air change due to the wind) or mechanically ventilated (where air is drawn into the buildings through vents due to a negative pressure created with wall fans that exhaust inside air.

Production Systems

Gestation sows on pasture

Before the 1960s, most pork in the U.S. was raised in outside lots or on pasture systems. With the development of slotted floors and liquid manure handling equipment, it became possible for producers to more easily care for larger numbers of animals, and to do so protect them from the weather. Enclosed buildings overcame most weather problems, predators and minimized the potential pollution from outside lot runoff. It also made it practical to farrow sows twice a year, rather than once. This was the beginning of intensive production schedules on relatively small areas as found throughout the world today.

In a continuous flow barn, animals of many different stages of development may be housed in close proximity to one another and the facilities are never empty. Advantages are that space is efficiently used, because pigs can be moved to larger pens as they grow, and new arrivals replace them in the smaller pens. Continuous systems are simple to plan; if the producer wants to wean two litters each week, two sows must be bred each week.

Disadvantages are that different ages of animals (with different degrees of disease resistance) are housed together, facilitating disease spread, stress levels can be heightened with changing social groups, adequate cleaning and disinfecting are not feasible, and higher levels of antibiotics and other medications are normally required to control disease.

Most swine today are raised in “all-in, all-out” (AIAO) systems, where each room or building is completely emptied and sanitized between groups of pigs. Each new group of pigs enters a freshly disinfected environment, and stays there for this phase of their life. The facility has a separate room or building for each group of pigs weaned, with extra space if needed to allow workers time to clean the room before the next group of pigs. AIAO animals in each room are of a uniform age and size and are isolated to the extent possible to decrease the possibility of diseases spreading from older animal groups to younger ones.

The primary advantages are that disease spread can be better contained, animals are less stressed because they remain with the same age and social group throughout their development, and complete cleaning and disinfecting between groups is possible. The

disadvantage is that space is less efficiently allocated, and that more space may be needed to allow rooms to be empty for cleaning between groups.

Until around 1990, swine production systems were usually housed on a single site, because of labour savings and convenience. Health concerns have since caused many swine operations to house the various production phases at different sites to further minimize contact between pigs of different ages. This is either a two-site or a three-site system. Two-site system has breeding and gestation at one site and farrowing/nursery and grows finish pigs at a separate site, while a three site also places the nursery at a separate site.

In the last few years, some producers have constructed “wean to finish” barns where pigs go immediately after weaning, and stay until market. This combines the nursery and grow-finish phases of production. These barns provide substantially more space per pig than is needed initially, but provide the advantage of only moving pigs once during their lifetime. This reduces stress on the animals and saves labor since buildings are not cleaned until the hogs are marketed.

Nutrition

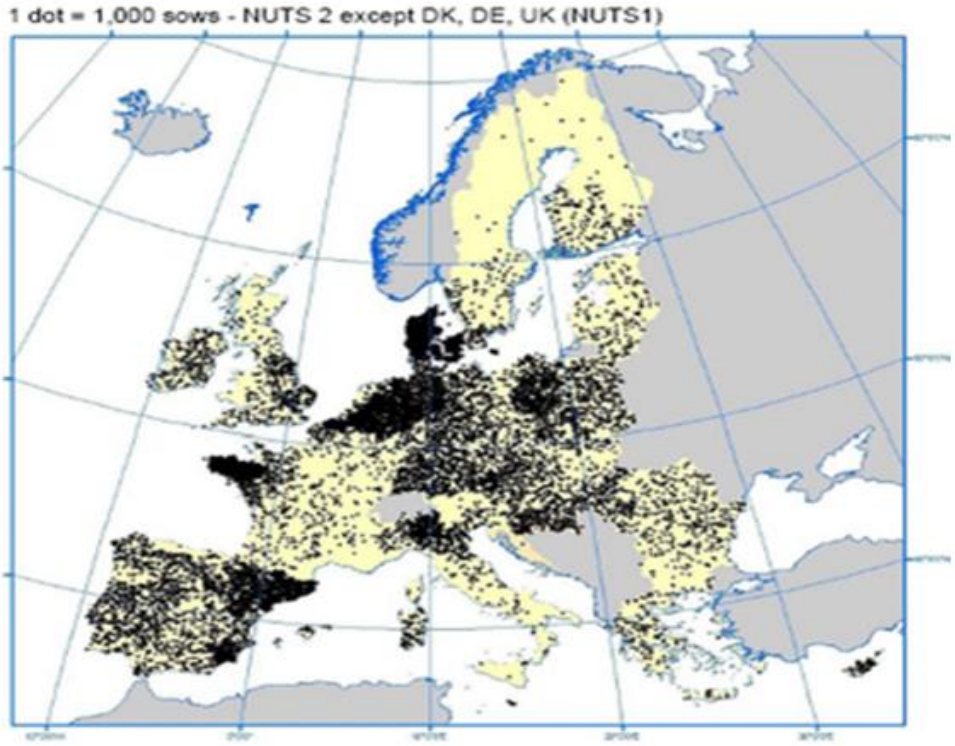
Swine have a digestive system similar to humans and different from ruminants such as cattle and sheep, which can eat forages or grasses. Pigs are fed a diet that is primarily ground corn to supply heat and energy and soybean meal to provide protein. Vitamins and minerals are also added in their feed. Rations are closely tailored to optimize health and growth at each stage in their life. Many producers even modify the ration based on the pig’s gender.

The ration is normally changed to provide more energy and less protein as the pig grows. The goal is to optimize feed utilization for different stages of growth. Since nutritional needs are different for male and female grow-finish pigs, larger operations may even modify the ration, based on gender. Recent studies indicate that ration modifications that can reduce the amount of nitrogen and phosphorous excreted in the manure, while maintaining optimum pig growth and health. It takes nearly 1000 pounds of feed to raise a hog to market weight. This same pig drinks about one-and-a-half to two gallons of water a day over its six-month life.

2.5.3 Swine production statistics in Europe

This article provides a general overview of statistics on pig farming in the European Union (EU). Pig meat is produced throughout the EU on several types of farms with considerable variations

from one Member State to another. Three quarters of pigs are reared by just 1.5 % of the largest fatteners. Small pig producers are mostly found in the new Member States and are one of the reasons for their smaller herd size. The different specialised tasks of pig rearing are distributed across farms and, in the main production basins, even across regions.



Map 3: Number of sows by region (2008)

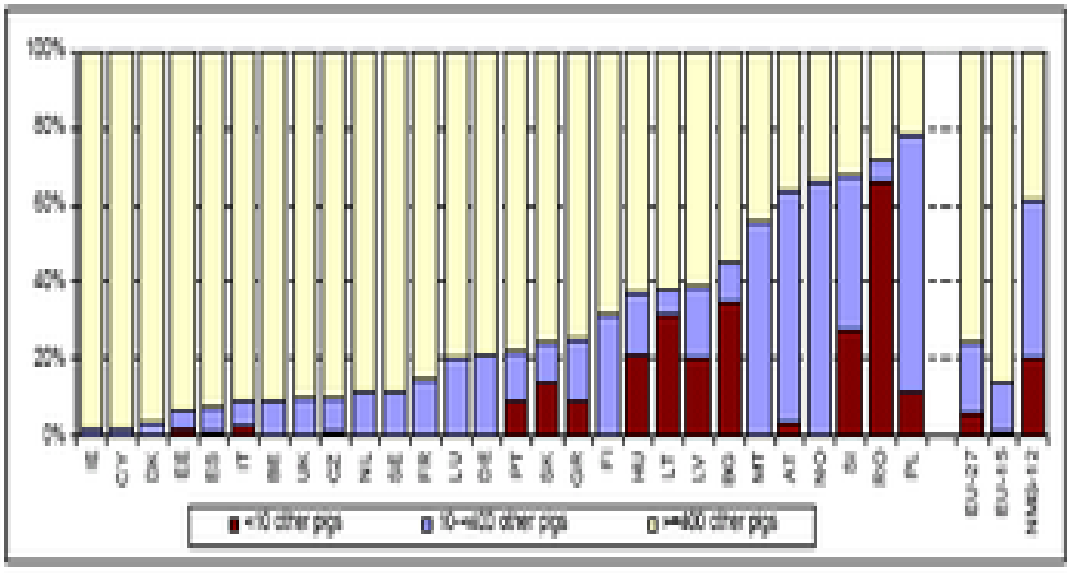


Figure 3: Distribution of numbers of other pigs by herd size (FSS 07)

Number of sows	None	>0-<100	>=100
Number of 'other pigs' <10	4.1% 'other pigs' 71.4% farms	23.3% 'other pigs' 27.2% farms 53.1% sows	
Number of 'other pigs' 10-<400			
Number of 'other pigs' >=400	36.5% 'other pigs' 0.8% farms		36.0% 'other pigs' 0.6% farms 46.9% sows

Number of sows	None	>0-<100	>=100
Number of 'other pigs' <10	4.1% 'other pigs' 71.4% farms	23.3% 'other pigs' 27.2% farms 53.1% sows	
Number of 'other pigs' 10-<400			
Number of 'other pigs' >=400	36.5% 'other pigs' 0.8% farms		36.0% 'other pigs' 0.6% farms 46.9% sows

Table 3: Distribution of pigs and farms by type of pig rearing (FSS 2007) - Four types based on the numbers of sows and of other pigs

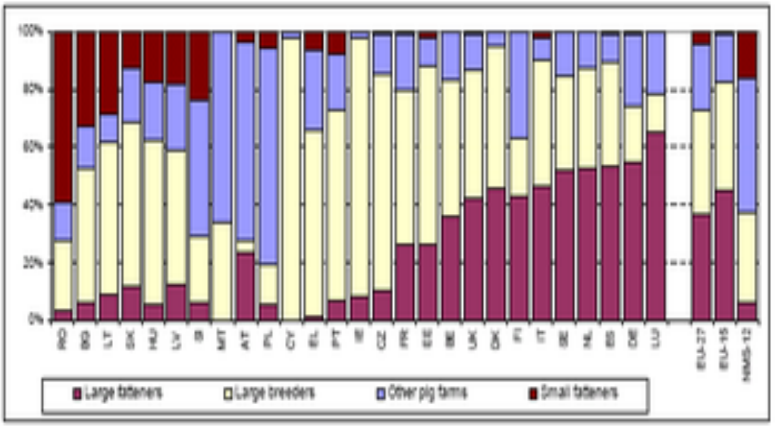


Figure 4: Distribution of other pigs by type of pig farm (FSS 2007)

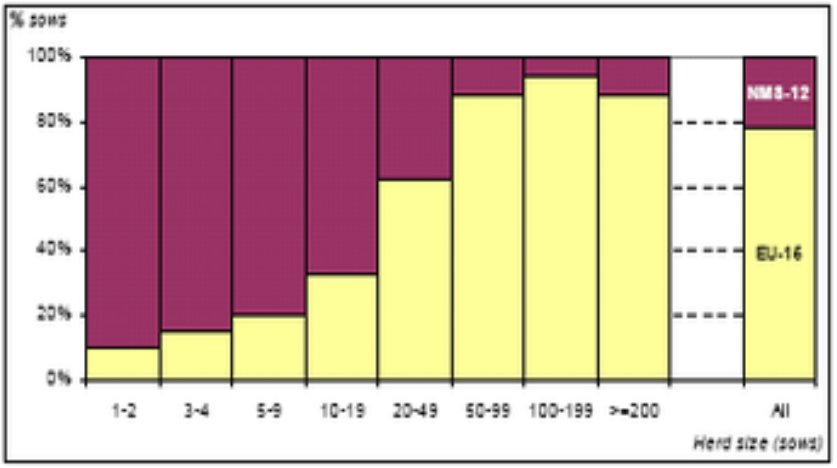


Figure 5: Distribution of the sows by herd size in EU-15 and 12 new Member States (FSS 2007)

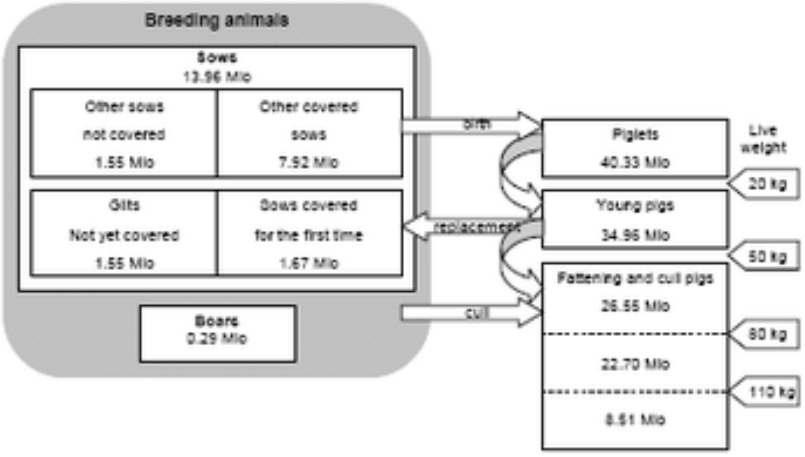
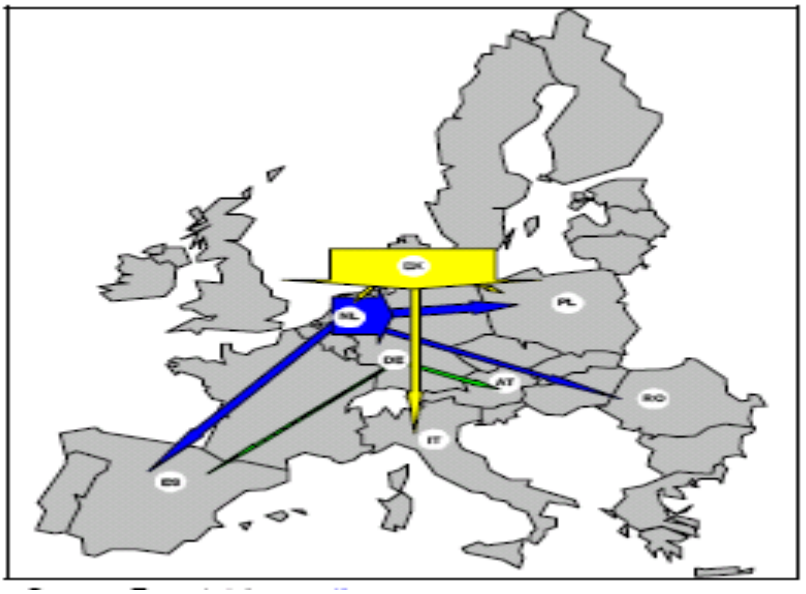
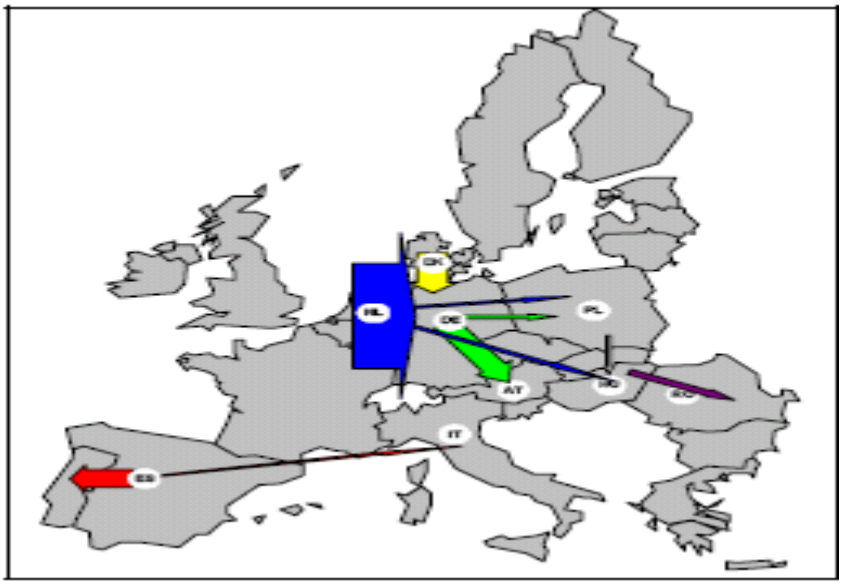


Figure 6: Pig population (EU-27) - Livestock population, December survey, 2008

Regional data on livestock are more informative than national figures as a means of displaying the zones of pig production (Map 1). The major production basin extends from Denmark to Vlaams Gewest (Belgium) and accounts for 30 % of EU sows. However, there are other important regions, such as Cataluña, Murcia (Spain), Lombardia (Italy), Bretagne (France) and some areas of central Poland and Northern Croatia. The distribution of national herds by size is taken from the Farm structure survey. The pigs are recorded in three categories, i.e. piglets, breeding sows and other pigs. The sows reflect the permanent pig herd and the other pigs are the pigs fattened before slaughtering.



Map 4: Net exchanges of young pigs - Scheme of the intra-EU exchanges (2008) - Arrow width is proportional to the volume of intra-EU foreign trade surplus (in tons). The 10 main surpluses on pigs weighing less than 50 kg account for 89% of the overall balances



Map 5: Net exchanges of pigs for slaughtering - Scheme of the intra-EU exchanges (2008) - Arrow width is proportional to the volume of intra-EU foreign trade surplus (in tons). The 10 main surpluses on pigs with a live weighing at least 50 kg account for 88% of the overall balances

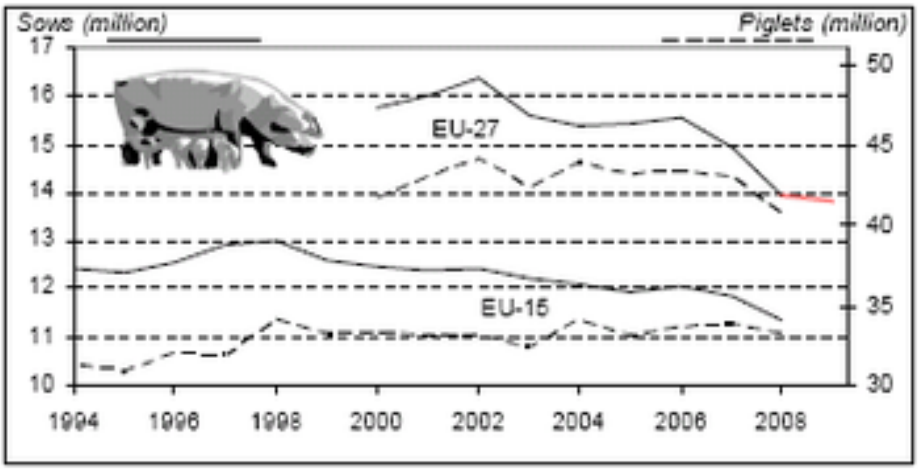


Figure 7: Change in the number of sows and piglets - In EU-15 and EU-27, December surveys

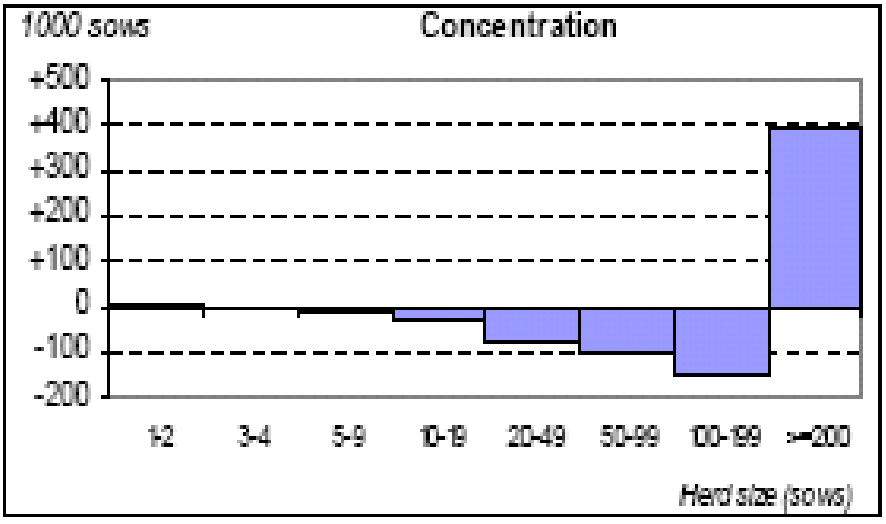


Figure 8: Change in the numbers of sows (FSS 2005 to 2007 - BE, BG, DK, DE, EE, EL, IT, CY, LV, LU, NL, AT, PT, FI and SE

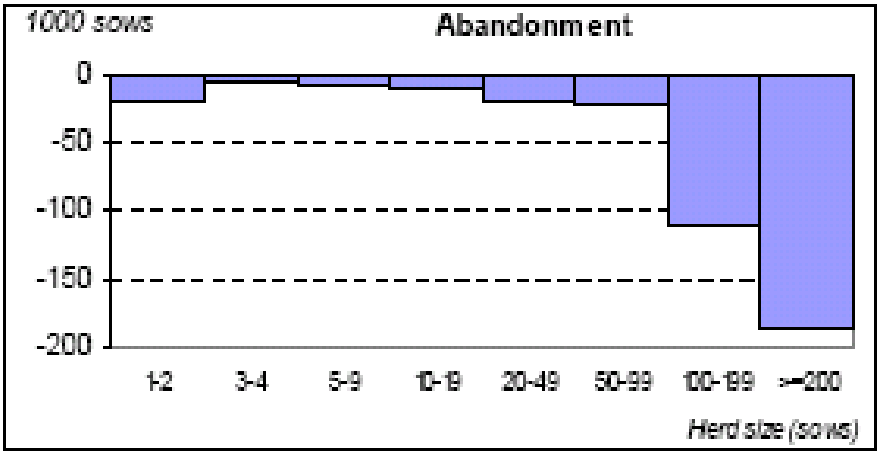


Figure 9: Change in the numbers of sows (FSS 2005 to 2007) CZ, IE, ES, FR, HU, MT, SI, SK and UK

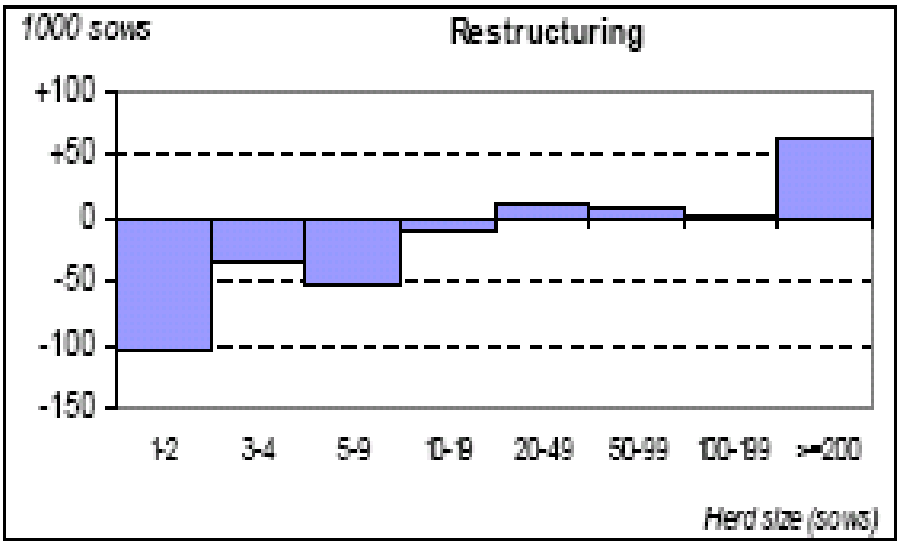


Figure 10: Change in the numbers of sows (FSS 2005 to 2007) LT, PL and RO

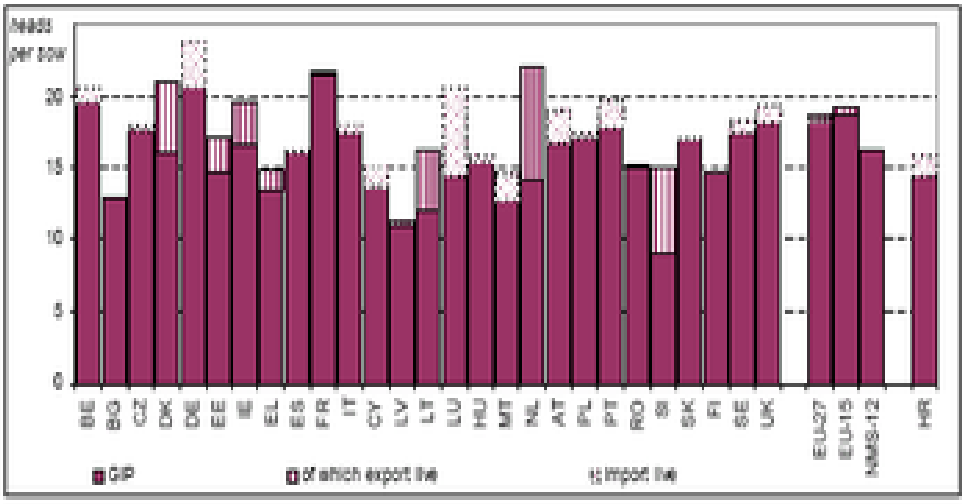


Figure 11: Numerical productivity (Gross Indigenous Production - GIP) per sow (2008)

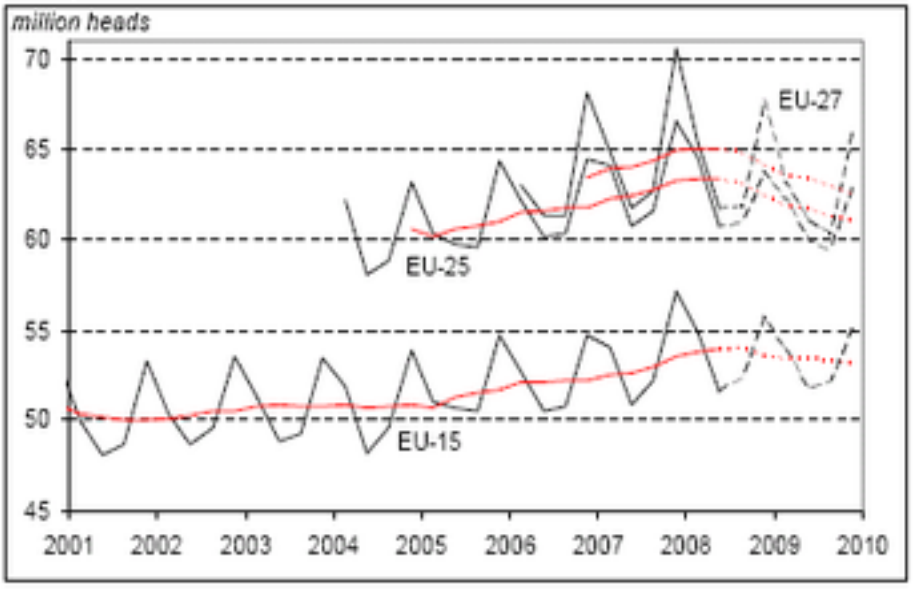


Figure 12: Gross indigenous production (GIP) of pig meat, quarterly data - Meat production forecast

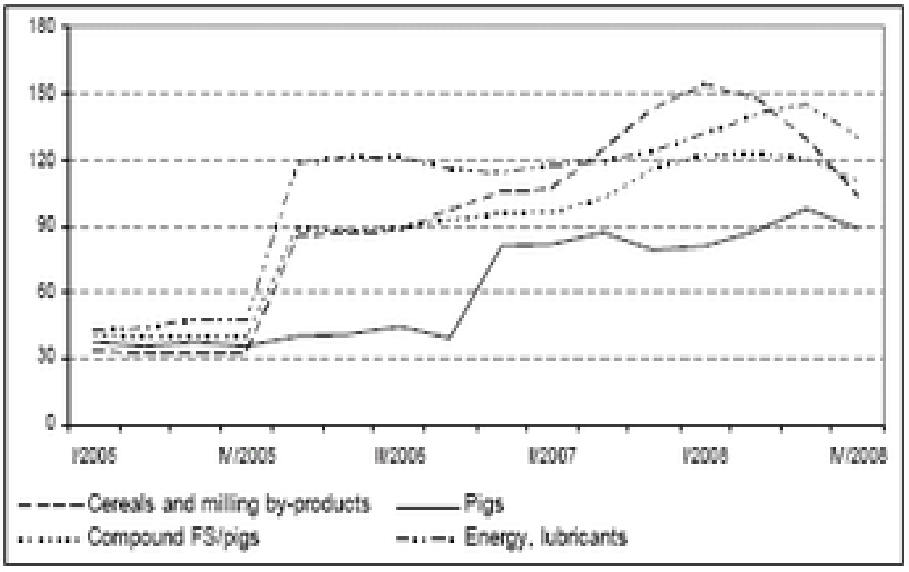


Figure 13: Price index of pig meat, cereals, energy and compound feedstuff for pigs - base 2000=100

Herd size: other pigs

The distribution of the pig population by size of the pig herds (in numbers of other pigs) shows that 1.5 % of pig farms have at least 400 other pigs and manage 75.7 % of these and 49.1 % of the sows. These figures conceal national differences: only 21.6 % of other pigs in Poland are kept in such farms as compared to the figure of 90 % or more in nine Member States (Ireland, Cyprus, Denmark, Estonia, Spain, Italy, Belgium, United Kingdom and Czech Republic). On the other hand, the animals kept in small units of less than 10 other pigs are important in Romania

(66.2 %), Bulgaria (34.8%) and Lithuania (31.9 %). At the EU level, although these small units manage 5.3 % of other pigs, they account for 85.8 % of the pig farms.

Herd size: breeding sows

Two types of pig farm may be distinguished based on the number of breeding sows: the fatteners and the breeder-fatteners. Almost half of the other pigs (47.3 %) are kept by fatteners, i.e. on farms without sows. However, this particular figure hides a range of different situations: 77.2 % of the other pigs are reared by fatteners with more than 400 animals, whereas 95.7 % of the fatteners have fewer than 10 pigs, mainly for own consumption. More than half of these numerous small farms (57.2 %) are in Romania.

Breeding sows, other pigs and herd size

Besides the numerous small fatteners, the other pigs are shared between three further significant types of farm. Of the largest farms with at least 400 other pigs, the pure fatteners and the large breeder-fatteners with at least 100 sows manage similar numbers of other pigs and the large breeder-fatteners feed almost half of the sow herd. A third group accounts for a quarter of the pig farms and manages one fifth of the other pigs and the remaining half of breeding sows.

The breakdown of other pigs among the four types of pig farm is shown by country.

- The small fatteners (no sows and fewer than 10 other pigs) represent a significant share of pig production and at least 10 % of other pigs in seven of the new Member States (Bulgaria, Latvia, Lithuania, Hungary, Romania, Slovenia and Slovakia). The importance of own consumption in pig production limits the sensitivity of this type of production to market conditions.
- The large fatteners (no sows and at least 400 other pigs) account for more than one third of other pigs in ten countries (Belgium, Denmark, Germany, Spain, Italy, Luxembourg, the Netherlands, Finland, Sweden and the United Kingdom). They reflect a production organized between specialized breeders (which nevertheless have other pigs) and fatteners. These 10 countries represent two thirds of the other pigs and three quarters of the EU pig meat production. In France and Estonia, the distribution is intermediate between that typical of large fatteners or large breeders.
- The large breeders (at least 400 pigs and 100 sows) manage more than two thirds of the other pigs in five countries (Czech Republic, Ireland, Greece, Cyprus and Portugal), where production is concentrated in a less organized production sector.

- The other pig farms manage more than two thirds of other pigs in Malta, Austria and Poland, which reflects a certain level of concentration, but one which is limited by the farm size. Slovenia, with almost half of the other pigs in such farms, also belongs to this group of countries.

Geographic distribution

Pig production is concentrated in a few countries, with Denmark, Germany, Spain, France, the Netherlands and Poland having more than two thirds of the breeding pigs between them (December 2008 survey). At regional level (NUTS1), half of the breeding pigs are concentrated in eleven regions, all of which are located in these six countries. Naturally, the size of the countries and regions plays a role in this ranking.

In relative terms, the average share of pig production in agricultural output is highest in Denmark (29 %), followed by Belgium (20 %), Poland (15%), Malta, Cyprus (both 14 %) and Germany (13 %).

Structural differences between pig farms in EU-15 and new Member States

Another striking feature is the high proportion of sows in small herds in the 12 newest EU Member States. More than 98 % of the sows are in farms with at least 10 sows in EU-15 as against 58 % in the new Member States. According to FSS 2007, the 12 new Member States accounted for 22 % of the breeding sows overall, but 91 % of these sows were in small herds of one or two sows and 6 % were in herds of 100 to 199 sows.

Components of the pig herd – types of animal

The livestock survey provides more detailed figures about the livestock population. The number of sows or piglets determines the number of fattening pigs, which in turn determines the number of pigs to be slaughtered several months later.

The number of boars per sow reflects the frequency of artificial insemination, and also the importance of the herds in natural service. This shows how rapid genetic progress can be. One boar covers on average more than 50 sows in Belgium, Ireland and the Netherlands, but fewer than 10 in Greece and Croatia.

The percentage of new sows (gilts) reflects the pressure to renew the breeding animals and is another determinant of genetic progress. The pig population can be divided into two groups i.e. breeding pigs and meat pigs. The former provides the production factors for the latter. The breeding pigs are renewed by keeping young pigs from the previous year and slaughtering

(culling) old pigs. The meat pigs can be sold at different stages as pigs to be fattened or as fattened pigs to be slaughtered.

Components of the pig herd – trade of live animals

The intra-EU exchanges (COMEXT) of pigs less than 50 kg amounted to around 200 000 tonnes in 2008. Assuming an average weight of 25 kg, this is equivalent to 8 million young pigs. This annual production, which represents a flow over year, cannot be compared directly with the population of young pigs at any given moment. Germany is the main importer of young pigs, with 77 % of EU imports, and Denmark is the main exporter with 74 % of EU exports. In addition, Germany is the main importer of breeding animals (46 %) and Denmark is the main exporter (23 %). Germany is also the main importer of non-breeder pigs weighing at least 50 kg, i.e. mostly for slaughtering.

It can be seen from these maps that pig production is specialised even across borders, with breeders such as Denmark, fatteners such as Spain and mixed producers such as the Netherlands. Germany, Denmark and the Netherlands form a single pig production area.

Changes in the Bar Chart on Respondent's

The *total number of sows* represents the production capacity. Between 2006 and 2008, the number of sows fell by 10 %. In the 12 New Member States the reduction was steeper (-27 %) than in the 15 older Member States (-6%), with certain exceptions in each group. The decline was less marked in Estonia and Latvia in the first group and in Italy, Luxembourg, the Netherlands and Portugal in the second group. In Greece the number of sows actually increased.

Such extreme changes are a combination of several phenomena, which have a varying impact depending on the structure of pig production. The general decrease concerns all countries, but the underlying phenomenon is one of concentration, i.e. an increase in the size of the largest herds together with the disappearance of the smallest. The trend is towards a decrease in the structure of pig production in the 12 new Member States can be expected to continue.

The most recent data come from the livestock survey carried out in May/June 2009. These figures are provided by countries with at least 3 000 000 pigs, and the Member States concerned account for 85 % of the EU pig population (according to the December survey). They show a yearly trend of -0.85 % for sows, -0.56 % for fattening pigs and -0.39 % for piglets, i.e. -

0.60 % for all pigs. This rate of change is less marked than that observed in previous years (-3.79 %) and indicates a lower rate of decrease. This would be comparable to the previous 5-year trend.

Changes in farm structure

The structural data allow us to distinguish three types of national trend, depending on the changes in the number of sows from large farms with at least 200 sows and of those from small farms with fewer than 10 sows.

- Concentration. In 15 Member States, large farms are accounting for more and more sows to the detriment of the smallest farms. The number of sows on small farms is barely falling, if at all. These Member States account for more than half (52 %) of the EU sow herd according to the December 2008 livestock survey.
- Abandonment. The decrease affects pig farms of all sizes, including large farms in nine Member States. These account for more than one third (36%) of the sows surveyed in December 2008.
- Restructuring. In three Member States, the number of sows from small herds fell sharply and the number in the medium and large herds rose correspondingly. This can be interpreted as a re-organisation of production. These herds accounted for one out of eight EU sows (12.4%) according to the livestock survey (December 2008).

A change is discernible in all countries, but it can be regarded as a trend in only some of them. The third type could also be seen as a combination of the other two.

Changes in the types of pig farm

The number of small breeders follows the trend in the number of small farms, i.e. a general decrease, which is especially marked where there are proportionally more small farms. The number of pigs is falling at a similar rate, as there is a strong link between these two numbers. The number of large fatteners is increasing apart from in a few countries. There, although the number of large farms is stable, their average size is continuing to increase. On average, between the 2003 and 2007 surveys in the 12 newest Member States, the number of pigs for the large fatteners doubled, with more extreme figures being seen at national level. At EU level, the increase was 16.4 %.

The number of large breeders has increased in only a few countries, the average number of sows per farm increased in every country, except Bulgaria, Austria and Slovenia. The average number of other pigs increased everywhere except in Luxembourg, Slovenia and Austria.
In all but a few countries, the number of other pig farms decreased, as did the number of sows and other pigs. Since the 2000 survey, the number of sows in these farms fell steadily by 2.5 % per year in EU-15.

Production of pig meat

Pig meat is produced from the slaughtering of live pigs produced in the country (gross indigenous production), i.e. excluding the pigs exported live, but including those imported live. Thus, the correspondence between fattening and slaughtering is not exact. Seasonal variations in production are due to lower sow fertility in summer. Pigmeat production shows an economic cycle (which is less than two and half years), although its impact on farmer decision is less than that of major economic changes or animal crises.

In 2008 pig meat production in the EU reached 259.6 million head, of which more than half (54.4 %) came from four countries (Germany, Denmark, Spain and France). The EU foreign balance showed a surplus of 1.8 million tonnes (pigmeat and processed pigmeat), i.e. 7 % of the slaughtering, but extra-EU trade represented only 14 % of the national foreign trade (in volume terms). Four countries (Denmark, Germany, the Netherlands and Spain) contributed 62 % to the total of extra-EU exports.

Finally, a statistical artefact also plays a role: the national statistics could cover domestic slaughtering, which has now been excluded for comparability purposes. Estimates have been used to minimize breaks in the series. Although the effect is concentrated in certain countries, it excludes about 7 % of pigmeat production in the EU.

Following the fall in the number of breeding pigs, production is also decreasing, and the GIP is expected to be around 250 million head in total for the four quarters of 2009.

Market prices

The past few years have been difficult for pig producers in terms of profitability mainly owing to the high price of cereals and, to a lesser extent, of energy. In parallel, the price of pigs increased only slightly and the terms of trade (output-input) remained negative. The situation at the beginning of 2009 warrants more optimism, but cannot compensate for these difficult

years. European Commission Rural development policy aims to improve competitiveness in agriculture and forestry, improve the environment and countryside, improve the quality of life in rural areas and encourage the diversification of rural economies.

As agriculture has modernized and the importance of industry and services within the economy has increased, so agriculture has become much less important as a source of jobs. Consequently, increasing emphasis is placed on the role farmers can play in rural development, including forestry, biodiversity, the diversification of the rural economy to create alternative jobs and environmental protection in rural areas.

2.5.4 Swine production in South Africa

The overall southern African pig population consists of a mixture of pigs introduced through diverse pathways. Migration between the 3rd and 7th centuries brought Iron Age communities with domesticated animals into the eastern parts of South Africa, with one archaeological record of a pig introduction at this time (Plug & Badenhorst, 2001). However, pigs most likely played an insignificant role as livestock. Early pastoralists in southern Africa found them unsuitable for a nomadic lifestyle while religious taboos, diseases and habitat favoured alternative types of livestock (Briggs, 1983; Plug, 1993; Bester & Küsel, 1998). Consequently, pig remains are not common in southern African excavation sites (Epstein & Mason, 1971). In more recent centuries, pigs were bartered from Chinese trading ships passing South African shores (Ramsay *et al.*, 1994). All other records from the sub-region date to post-European contact (Plug & Badenhorst, 2001). Passing Portuguese travellers imported pigs as a medium of exchange with local populations (Quin, 1959), and a last phase of introduction began in the 16th to 17th century when European breed types were introduced (Bester & Küsel, 1998).

According to figures from the South African Department of Agriculture, Forestry and Fisheries, pig farming in South Africa had developed into a national industry with an estimated 1,613 million pigs by 2009 (DAS, 2010). Modern methods are used for performing recording, including the PIG BLUP system applied by the ARC Animal Improvement Institute from 1993 (Visser, 2004). Established commercial breeds farmed in South Africa include the South African Landrace, the Large White and the Duroc. Ancestors of the South African Landrace were originally developed in Denmark and from 1949 exported to various countries from 1949 (Treacy, 1976). It is now the second best represented commercial breed in the country (Visser *et al.*, 1993). The Large White was first recognized as a distinct breed in England in 1884 (Briggs, 1983). This breed is currently one of the two major maternal populations in the world (Ruvinsky

& Rothschild, 1998). The Duroc was developed in the USA and has become important as terminal sires in many countries (Ruvinsky & Rothschild, 1998). It is the fastest growing breed in the world during the last quarter of a century. The first Duroc pigs have been imported into South Africa from Canada in 1980 primarily for cross-breeding purposes (Visser *et al*., 1993). Molecular data describing levels of diversity in these breeds following various periods of utilization in South Africa are not available.

A number of distinct indigenous pig populations have been identified in southern Africa, but historical information on the origins of these populations is very limited. The Kolbroek is an indigenous South African phenotype of unknown origin. Kolbroek pigs are hardy, survive by scavenging outside homesteads, do well on a high fibre diet and have high disease tolerance and a docile nature (Visser, 2004). Namibia also hosts a population of indigenous pigs of uncertain origin. In Mozambique, pigs of an unimproved type are found around villages, for example in the Tete Province.

Indigenous pigs were long regarded unsuitable for intensive commercial breeding because of their slow growth and inadequate meat production (Prolit, 2004). Nevertheless, many local African domestic animal populations exhibit well-established adaptations to prevailing environmental and management conditions. This represents a valuable genetic resource for improving breeds and the efficiency of animal production. Indigenous populations may add potential characteristic genetic variation which could be valuable to producers in supplying new diversity for the improvement of commercial lines (Blott *et al*., 2003). Furthermore, a progressive trend towards more environmentally effective pig production and small-farm systems, together with data on the potential of indigenous pigs as converters of fibre, root and leaf crops, have shown that these animals are invaluable to the small-scale rural farmer (Ramsay *et al*., 1994).

The status of genetic diversity in southern African indigenous and commercial pig populations is currently unknown. This study aimed to genetically characterize the three principal commercial pig populations of South Africa and the indigenous pig populations of southern Africa, and to determine levels of diversity within specific breeds and populations, using molecular markers.

2.5.4.1 Swine Distribution in South Africa

Swine production has contributed tremendously to the agricultural sector of South Africa. It contributes around 2.15% to the primary agricultural sector of the country. South Africa's pork industry is well organized and compares favourably with the rest of the world. Over 400 SA pork producers manage 100,000 sows and produce more than 150 metric tons annually.

Pork is produced throughout South Africa with Limpopo and North West province taking the lead accounting for 44% of the total production (i.e. Limpopo 24% and North West 20%). Free State contributed 8% of the total annual production. According to the South African Agricultural Baseline, Bureau for Food and Agricultural policy (BFAP) 2011 report, pork production was projected to respond to lower feed prices and increase to about 170,000 tons in 2010. Consumption was also expected to increase in 2011 on the back of economic recovery and favourable pork prices compared to other meat type.

2.6 Best Management Practices (BMPs) in Swine Production

Best Management Practices or BMPs refer to operating techniques and good housekeeping principals for reducing and preventing pollution before it occurs (Illinois EPA, 2015). The overall philosophy behind BMPs is to conduct everyday activities in a more environmentally-sound manner, recognizing that it may not always be practical to control or manage pollution after it is generated. By using BMPs, a facility can help protect the environment, save money, and improve community well-being all at the same time.

Swine operations have a number of sources which can potentially generate odors or pollute ground water or surface water resources, including:

- the hogs themselves,
- open feed lot operations (uncontained runoff which is collected in a settling basin and holding pond),
- spilled feed,
- confinement operations (confinement buildings, manure collection systems, storage systems, livestock waste handling facilities, or lagoon treatment system),
- dead animal disposal.

Odours from pork production emanate from decomposition of livestock waste, from spoiled feed and from dead animals. Livestock waste is the most significant and consistent odor source.

BMPs can help pork producers comply with environmental requirements and improve their performance over the long term. Most BMPs are based on common sense and can be implemented quickly and at low cost, through simple changes to general housekeeping procedures or in-house process changes.

The purpose is to help pork producers identify BMPs that will improve their operations and reduce the potential for generating odors and release of contaminants to ground water and surface water resources. Because each facility is unique, not every practice may be suitable. Each suggested BMP will need to be judged on a case-by-case basis, taking into account the conditions, operations and limitations of each facility. Pork producers are encouraged to individualize the BMPs to their operations and site conditions, and to develop their own solutions for preventing pollution.

The BMPs listed below are divided into four categories, covering a specific operation or management task.

Grounds

BMPs involving the grounds at pork production facilities is basically using common sense and being considerate of your neighbors. Below are examples of BMPs activities that you may be able to implement at your facility:

- locating the facility as far as possible from surface water bodies
- locating the facility in an area with sufficient soil drainage
- having wind breaks and buffer strips around the facility
- diverting rain water away from areas where it could become contaminated
- maintaining proper gravel cover and landscape gradient so that water does not stand in access roads and around the production facility
- scraping away manure in open feed lots to reduce buildup of solids and to control odor and fly production
- collecting runoff from lots in settling basins for subsequent land application
- immediately loading manure into a manure spreader and directly applying to the field
- removing spilled feed promptly
- keeping feeder equipment in good repair
- keeping watering devices in good repair

Buildings

Routine maintenance and good housekeeping practices are the two easiest ways to prevent pollution in buildings. Some ways that you can use BMPs in buildings are:

- constructing interior surfaces with smooth materials to reduce dust and grime accumulation and facilitate cleaning
- maintaining adequate ventilation in the building to prevent buildup of dusts, gases, moisture and heat
- preventing liquids from collecting under animals and watering equipment by using slatted floors or other technologies
- repairing leaking water lines immediately
- maintaining clean and dry buildings
- installing an under-floor ventilation system in confinement buildings where below floor storage is used
- using a power washer when hosing down walls, dividers and floors in order to reduce water usage
- covering feeders and extending feed downspouts to minimize dust
- scraping off or flushing away of manure in confinement areas on a frequency which is adequate to minimize odors
- covering sumps at lift stations
- pumping manure from accumulation areas to storage areas on a frequency which is adequate to prevent odors and overflow
- Lagoons, Settling Basins and Holding Pond
- Lagoons, settling basins and holding ponds which are undersized or poorly designed causes pollution. Below are some examples of ways to improve your lagoons, settling basins and holding ponds:
- locating lagoons, settling basins and holding ponds away from valley type topography which can trap odors in low lying areas
- constructing lagoons, settling basins and holding ponds so that wastes do not overflow or leach into groundwater and that odor is minimized
- covering the lagoon, settling basin or holding pond to reduce surface odors being released
- adding aeration
- pumping or draining manure to a lagoon in small enough quantities to avoid slug loadings to maintain a stable microbial population within the lagoon

- maintaining sufficient storage capacity to prevent overflow of lagoons, settling basins and holding ponds
- using a pump and a solids separator to lower solids loading
- removing sludge from the primary lagoon frequently enough to prevent overloading or carryover of solids to a second stage lagoon
- equipping lagoons and holding ponds with a free-board gauge so that it can be determined when it is necessary to pump out and land apply supernatant and prevent overflows
- dewatering lagoons no more than the minimum treatment volume level as indicated on the lagoon marker
- filling new or emptied lagoons with water to the minimum treatment level before manure is introduced

Land Application

Manure as a fertilizer can be environmentally beneficial. However, there are additional opportunities for reducing pollution when applying the manure to the land. Some examples of BMPs in land application practices are:

- developing a manure management plan
- scheduling application times that are compatible with crop rotations
- having sufficient land available to land apply during various times of the year so that the rate of application will be at or below agronomic rates
- locating land application sites away from valleys
- applying manure on fields that are not highly erodible
- applying manure early in the morning until early afternoon
- applying manure on days with low humidity and little or no wind
- applying manure at a site remote from neighboring residences if manure is not injected or immediately incorporated into the soil
- applying manure on land which is not frozen or snow-covered
- preventing contaminated runoff by not applying to land which is saturated or contains ponded water
- preventing contaminated runoff by not applying manure near a creek or river or fields adjacent to them
- preventing contaminated runoff by not applying manure during precipitation or when precipitation is imminent

- injecting manure with a tank wagon equipped for manure injection
- determining the necessary application rate and properly calibrating your equipment
- using injection equipment which leaves crop residue intact and creates a level surface to plant crops without further tillage
- irrigating cropless fields at low enough rates to allow liquid manure to be incorporated within 24 hours of application
- applying liquid wastes at low pressure with little agitation if spreaders or sprayers are used to land apply
- sealing manure application equipment and cleaning disks used to incorporate manure if travel on public roads is necessary

BMPs are practices used by producers to control the generation of pollutants from agricultural activities and to thereby reduce the amount of agricultural pollutants entering surface water and groundwater. Each BMP is the result of years of research and demonstrations conducted by agricultural research scientists and soil engineers.

The swine industry is one of the smaller animal industries in Louisiana, contributing approximately $2.58 million to the state's economy in 2010. Louisiana's swine production focuses primarily on raising feeder pigs for youth livestock projects, showing or direct sale at auction barns. Although swine farms are located across the state, the greatest production is in St. Martin, Vermilion, Calcasieu, Avoyelles, Rapides, West Feliciana and Beauregard parishes. Swine production, by its nature, requires specific practices to conserve and protect soil and water resources. Best management practices, often known as BMPs, are an effective and practical means of reducing point-source and nonpoint-source water pollutants to levels compatible with environmental quality goals. The primary purpose for implementation of BMPs is to conserve and protect soil, water and air resources. BMPs for swine farms are a specific set of practices used by farmers to reduce the amount of soil, nutrients, pesticides and microbial contaminants entering surface water and groundwater while maintaining or improving the productivity of agricultural land. This list of BMPs is a guide for the selection and implementation of those practices that will help swine farmers conserve soil and protect water and air resources by reducing potential pollutants and/or keeping them from reaching both surface water and groundwater. Sediment is the largest pollutant by volume of surface water in the Nation. Sediment comes from agricultural sources, construction sites and other soil-disturbing activities in urban settings that leave the soil exposed to rainfall. Sediment increases the turbidity of water, thereby reducing light penetration, impairing photosynthesis, altering

oxygen relationships and may reduce the available food supply for certain aquatic organisms. It can affect fish populations adversely in areas where sediment deposits cover spawning beds. Increased sediment also fills lakes and reservoirs.

By implementing and using best management practices, Louisiana hog producers are minimizing pollution of water resources of the state as well as saving money in many cases. Sediment runoff reduction is one of the most important practices a hog producer can adopt – from an economic and environmental perspective. Based on volume, sediment is the largest pollutant of surface water in the nation. Sediment pollution comes from several sources, including all agricultural operations that leave bare soil exposed to rainfall. From an economic perspective, allowing nutrient-laden soil to run off the swine farm and into rivers and streams is a financial loss to the operation. Soil lost in this manner can never be used again to produce forage or grazing pastures to support your swine operation. Retaining as much soil as possible can reduce the amount of fertilizers and other soil amendments needed to maintain adequate forage and grazing acreage.

One negative environmental effect that is increasingly noticed and can cause much concern to the public and environmental regulatory agencies involves increases in the turbidity of water, thereby reducing light penetration. This, in turn, results in impairment of photosynthesis, and the altering of oxygen relationships that can reduce the available food supply for certain aquatic organisms. Excessive runoff can adversely affect fish populations in areas where sediment deposits cover spawning beds and, in some situations, given a long enough period of time, partially fill in ponds, lakes and reservoirs.

In addition, sediment is often rich in organic matter. Nutrients such as nitrogen and phosphorus and certain pesticides may enter streams with sediment. The potentially harmful effects may include rapid algae growth, oxygen depletion as organic matter and algae decompose, fish kills from oxygen depletion, toxic effects of pesticides on aquatic life and unsafe drinking water caused by high nitrate or pesticide content. Manure runoff reduction is of paramount importance to swine producers. Every producer should practice all cost-effective methods to ensure lagoon, paddock and parlor wastes are handled and treated properly. One of the greatest concerns of the regulatory agencies and the public is the escape of manure runoff and the accompanying bacteria and nutrients that can enter the streams and tributaries of Louisiana's surface waters. Many of the water bodies in Louisiana that are listed as impaired and require attention by the U.S. Environmental Protection Agency and the Louisiana

Department of Environmental Quality are polluted with fecal coliform bacteria and do not meet their designated use for swimming, water contact or fishing. Although not all of this pollution can be attributed to livestock operations, in the public's minds, livestock is always at least part of the source. Fecal coliform is a term used to describe bacteria found in the intestinal tract of warm-blooded animals. Surface waters are monitored for the presence and concentration of fecal coliforms. Not all coliforms are harmful to human health. In fact, some fecal coliforms are normal and essential for human digestion. Without them, our digestive system would not function properly. If fecal material is present in stream segments in excessive concentrations, the Louisiana Department of Health and Hospitals states there is the potential for other harmful pathogens to also be present.

Some forms of coliforms such as a few strains of E. coli can be transmitted from livestock to humans or from person to person and may be harmful to human health. When excessive concentrations of fecal coliforms are found in monitored rivers and streams, the DHH may issue advisories or order closures of the affected surface waters. In addition, manure runoff also contains nitrogen and phosphorus and can result in nutrient over enrichment of water bodies, which can cause algae blooms and oxygen depletion in surface waters, resulting in fish and other aquatic animal kills. Nutrient management is another profoundly important aspect of swine operations, and much attention is given to this aspect of swine management in this manual. Excessive nutrient runoff can cost the farm significant amounts of money. Often, without a comprehensive nutrient management plan, hog producers may apply too much of the essential elements. When that occurs, it's just money down the river. Excessive nutrients cost the operation money and ultimately run off the farm and pose environmental problems in nearby surface waters.

Feed Management Self-Assessment

The amount of livestock manure produced and the intensity of odors can be manipulated through feed management. A ration with lower amounts of nondigestible materials will have fewer materials passing through the animal and out as manure. Since many odors are related to nitrogen and phosphorus, a ration that reduces nitrogen and phosphorus in the manure will produce lower amounts of odor. The checklists that help to assess the viability of feeding management options to consider are as follows:

Grouping –placing animals of similar ages, weights and/or production levels together.

Gender –placing animals of the same gender together.

Climate –adjusting the diet to meet specific climate conditions, such as temperature or precipitation, or adjusting the building climate to optimize nutrient use.

Feeding program –using a multiphase feeding versus minimal-phase feeding; dividing the growth period into several periods with a smaller spread in body weight allows producers to provide diets that more closely meet the animal's nutrient requirements.

Waste –minimizing spills or waste of feed and water.

Feed processing –pelleting, extrusion, steaming, micronisation and reducing particle sizes increases digestibility of diets for pigs.

Diet Manipulation Factors

Available nutrients –knowing the availability of nutrients in feed ingredients and formulating diets on an available nutrient basis is very important in diet manipulation.

Nutrient levels –some nutrients may be excessive in commercial animal diets; chemical analyses of ingredients and reformulation are critical to minimize excesses, but nutrient reductions can only be achieved as long as they are economically feasible.

Genetics –knowing the genetic capability of the animals, including feed intakes and responses to environmental conditions, is important to developing appropriate diets.

Feed efficiency –using antibiotics and other growth promoters will increase feed efficiency, thereby reducing nutrient excretion.

Specialty feed ingredients –providing specific feed ingredients (such as high-oil corn, nutrient-dense corn, highly available phosphorus corn and soybeans and phytase enzyme) helps achieve a proper balance or increase availability of nutrients.

Water supplies –source of water can make a significant contribution to mineral intakes that is being pumped. Producers with multistage systems should draw samples from the lagoon they intend to pump for crop irrigation. Samples should be collected using a clean, plastic container. One pint of material should be taken from at least eight sites around the lagoon and then mixed in the larger, clean, plastic container. Effluent should be collected at least 6 feet from the lagoon's edge at a depth of about a foot. Shallower samples from anaerobic lagoons may be less.

Odor nuisances -Odor nuisances are the primary driving factor behind more restrictive local zoning laws for agriculture. Better management of manure nutrients through increased reliance on manure storage and land application of manure in narrow windows of time may add to or reduce odor complaints due to weather conditions or the location and your relationship with neighbors. Manure application systems that minimize odor deserve consideration and preference when neighbors live near application sites.

Application

Soil compaction -Manure spreaders are heavy. In a 3,000-gallon liquid manure tank, the manure alone weighs more than 12 tons. In addition, manure often is applied at the time of year – late fall and early spring – when high soil moisture levels and the potential for compaction are common. The impact of manure application on potential soil compaction requires consideration.

Timeliness of manure nutrient applications -The ability to move large quantities of manure during short periods of time is critical. Limited opportunities exist for the application of manure to meet crop nutrient needs and minimize nutrient loss. Investments and planning decisions that enhance the farm's capacity to move manure or to store manure in closer proximity to application sites will facilitate the improved timing of manure applications. Irrigation Systems a properly designed irrigation system provides the operator the opportunity to uniformly apply wastewater at agronomic rates without direct runoff from the site. A "good design" does not guarantee proper land application, however. The performance of a well-designed system can be ruined by poor management; likewise, a poorly designed system can sometimes provide good performance with proper, intensive management. You should be familiar with your system components, range of operating conditions, and maintenance procedures and schedules to keep your system in proper operating condition.

2.7 Effect of Stocking Density on Growth Performance

Intensive production systems require that inputs and facilities be used in the most efficient manner. Stocking strategy can have a significant effect on the output from pig units. Crowding can result in depressed pig performance while under stocking can cause reduced pig meat output. Stocking density has a significant impact on growth performance. Stocking rate can have a major impact on the intake of feed as a result of space restrictions.

Recommendations for finishing pig stocking density vary from approximately 6.0 to 9.0 ft2 per pig, depending on factors to be optimized. Pig performance is improved with more space per pig, while facility cost per pig, economic return, and overall efficiency are likely to be improved with less space allowed. Other factors, including pig flow and facility availability, also affect practicality of achieving an optimum stocking density. A report by the National Pork Board (2005) indicated that, on average, swine operations stock pens at approximately 7.2 ft2 per pig. Understanding the effects of different stocking densities on performance can aid pig flow decision-making and help producers maximize income by balancing fixed costs with effects on performance.

Stocking density did not affect (linear; $P \geq 0.20$) ADG, ADFI, or F/G within the first 14 d of this trial (Table 1). In all subsequent periods, ADFI decreased (linear, $P < 0.001$) as stocking density increased, which led to a decrease (linear, $P \leq 0.02$) in ADG in all periods except from d 56 to 70. Stocking density did not change feed efficiency except for a small linear improvement ($P = 0.02$), from d 56 to 70, as density increased.

Overall, as stocking density increased ADG and ADFI decreased (linear; $P < 0.001$), and F/G was not affected (linear; $P = 0.99$). On d 99, pig weights decreased (linear; $P < 0.001$) as stocking density increased, which resulted in a 13.2 lb increase in pig weight due to pens being stocked with 22 pigs compared to the pens loaded with 28 pigs. These data indicate that in this commercial barn, finisher pig ADG and ADFI was improved as stocking density was reduced.
The relationship between space allowed per pig (m2 or ft2) and weight in kg raised to the two-thirds power (BW0.67) can be determined using a value defined as the k-value ($m2 = k \times BW(kg)0.67$) (Whittemore 1998). After a review of published studies, Gonyou et al. (2006) reported a range of k-values (range: 0.0335 to 0.0358 m2/BW0.67) below which feed intake was reduced for pigs on either fully or partially slatted floors. Thus, representative value of 0.035 m2/BW0.67 defines a critical limit below which feed intake is reduced due to inadequate space allowance per pig (Torrallardona & Roura, 2009). Regardless of potential other contributing factors, results show that growth rate and feed intake increased as stocking density per pen decreased.

When growing-finishing pigs are given less than optimal space per pig, feed intake always decreases (Brumm et al., 2001), often resulting in a reduction in average daily gain (ADG), with variable effects on the gain: feed ratio (G:F). Social interaction with another pig reduces growth performance and feed intake regardless of stocking density. Swine producers try to maximize profits by minimizing both performance retardation and underutilized space. Crowding stress

deleteriously affect the growth performance of pigs. Pigs, housed on deep-straw for six weeks in groups of 20 or 80, were provided with a low (50 kg/m2) or high (32 kg/m2) space allowance (Turner et al., 2003).

Wolter et al. (2003) investigated the subsequent effects of eight weeks space restriction in weanling pigs. For eight weeks, space restricted pigs showed growth retardation when compared with pigs provided with adequate space (27.4 vs. 29.3 kg of BW). Smith et al. (2004) reported that nursery pigs with the greatest space allowance (0.35m2/pig) were 5.6% heavier than pigs with the least amount of space (0.23m2/pig). Kerr et al. (2005) demonstrated that growing pigs maintained at low stocking density had a higher weight gain (8.23 kg) than their high stocking density counterparts (7.42 kg) for five weeks at the same room temperature. White et al. (2008) reported that reducing stocking density from 0.93 to 0.66 m2/pig resulted in 4.0% less body weight, 17.0% less ADG, 10.7% less average daily feed intake (ADFI) and a 7.8% less G:F ratio. Recently, Cho et al. (2010) reported that for the six-week nursery period, the crowding reduced ADG of gilts (577: 0.50 m2/pig, 536: 0.25 m2/pig, and 558 g/d: 0.25 m2/pig) and barrows (578, 539 and 527 g/d).

Swine industry is changing on a large scale. High stocking density reduces the welfare of swine. Numerous results of researches show that the negative effects on performance were associated with large groups and the reduced floor-space allowance. The manner in which a pen is stocked or in which swine are marketed did not affect individual swine performance but did have a significant effect on the swine meat output per unit area. Increasing the stocking density within a specific range results in increased output per pen, but split-marketing had the converse effect of decreasing output. Facilities were used most efficiently at the highest stocking density and by marketing the pen group on a single day.

2.8 Profitability of Swine Production

Production and management of pigs was affected by lack of organizational strategies to achieve economies of scale at farm level, poor access to market information, limited use of fair and meaningful quality standards, feed shortages during the dry season, disease risks such as African swine fever, and limited access to extension services, agricultural insurance, credit and other financial services. We found that the profit per pig was UShs.17495. Experience in years, amount of land area under piggery use, number of workers, number of pigs sold, making and use of budgets, record keeping and availability of extension services were found to have a significant relationship at 5% with the profit made from piggery business. The piggery business

can be made more profitable by establishing farmer groups through which they can save some money and build capital for further investment in their farms. Cooperatives from where farmers can borrow money to support their farming activities should also be introduced. Farmers should be provided with proper extension services, genetically better and more disease resistant pig breeds.

Almost two thirds of rural households in developing countries are partially or fully reliant on livestock for their livelihoods (Pica-Ciamarra et al., 2015). This is because livestock rearing provides them with a host of benefits, such as food, income, manure, savings and insurance, renewable energy, and social status (Kugonza et al., 2012a; Pica-Ciamarra et al., 2015). Despite falling behind the ruminants in the pecking order, largely due to religious and cultural restrictions on pork consumption, pig business plays a central role among urban and peri-urban farmers in many developing countries (Kugonza et al., 2015). In Africa, Uganda is the leading pork consuming country with a consumption rate of 3.4 kilograms per person per year, and this could be due to rising incomes or shift in preferences (Dione et al., 2013). About 1.1 million Ugandan farmers, most of whom are women keep over three million pigs in smallholder households with limited access to technology, information and services (Dione et al., 2013). Pig farming is nevertheless becoming a big business in Uganda than ever before (Karaimu, 2014). Indeed, over the past 40 years, the volume of pork consumed in developing countries has steadily increased up to 70% (Muhanguzi et al., 2012). The pig industry in Uganda plays an important role in improving the standard of living by creating employment opportunities, providing a source of food and generating income (Ikanni & Dafwang., 1995). Pigs are also assets that are often utilized to weather down the negative effects of unexpected shocks (Tatwangire., 2013). They also play an important role in risk diversification and livelihood security of smallholder and poor households (Ouma et al., 2013).

Despite the above rosy picture, the pig industry in Uganda is characterized by low output; with small-scale producers in the rural areas largely sustaining the industry (NAADS, 2011). It is common for communities to have pigs rooting and roaming freely around the dwellings, to be sold as and when the household needs income (Muys & Westernbrink, 2004). There are just a few commercial pig farmers in Uganda, as the pig industry has largely been unable to attract any big local or foreign investments (NAADS, 2011). It is expected that the consumption of pork will increase further in the future owing to human population growth and increased per capita consumption (Galeboe et al., 2009). Substantial research has been carried out on different aspects of piggery management, but little emphasis has been put on measuring profitability and

hence ensuring that pig farmers attain maximum revenue from their piggery businesses. This study was therefore conducted to determine the factors affecting profitability and how incomes can be maximized in piggery enterprise.

2.8.1 Profitability analysis of Swine

2.8.1.1 Gross margin analysis

On average farmers attained a profit of US$65 from each pig. This was calculated by subtracting the average total variable costs from the average total revenue, the margin is quite high compared to the low inputs used on the pig farms implying that pig farming is relatively profitable. It appears that more profit would be attained with better management skills. Farmers in this study did not incur significant marketing and labour costs and they also had low cost access to basal feeds (vegetation and kitchen refuse), hence failing to attain maximum pig productivity. Khem et al. (1997) stated that efficient use of inputs, especially feed and labour is more important to profitability than maximizing productivity in terms of pigs weaned per sow. Also, Dwight et al. (2012) posited that most profitable producers are characterized by production efficiency: greater output with the same amount of input.

2.8.1.2 Break even analysis

Farmers reported that they were able to break even, since they attained profits from their businesses. However, this was because many of them did not invest a lot in fixed capital since their farm structures were temporarily made of wood. Pig farms with smaller herds are characterized by wide variability in costs and low capital investments (Khem et al., 1997).

2.8.2 Regression analysis

2.8.2.1 Major factors affecting profitability

Marketing is one of the major factors that influence farm profitability among farmers. If it is easy to acquire market then income is easily generated hence profits; while if it's harder to get market, then income is not easily accumulated hence less or no profits in the end are realized. It has been proved that the economic changes in the production can be explained by the change of the relationship between the selling and purchasing prices of the pigs (Babovic et al., 2011).

Availability of extension services was another factor that affected profitability. Most of the farmers lacked knowledge on important management practices that would help them increase on their production. This was because extension services were not available to most of the farmers. Most of the farmers depended on knowledge from their own experiences which was

not sufficient. The few farmers (12.5%) that had a chance to interact with extension officers gained better skills on how to manage their piggeries for better results. Also, some farmers were provided with better pig breeds that grew faster and were more tolerant to diseases which things could not be gained by the others. This was reported by the farmers that attained theses services.

Availability of veterinary services; pig health has a direct impact on weight and quality which also determines the price at which the pig will be bought or sold (Sharma et al 1997). As mentioned earlier, some of the farmers (37.2%) did not provide adequate veterinary services for various reasons. This was reflected in their final products as most of them sold their pigs at very low prices and hence attained less profit.

2.8.3 Profitability Measures

The net profit margin [total revenue-total costs (including inventory adjustments)] per hundred pounds of pork produced serves as our primary measure of profitability. This is consistent with other measures in the literature and with economic theory of the firm which focuses on costs and profits per unit of output. However, other measures of profitability may also be important to producers.

2.8.3.1 Cost Measures

Here, the producers are sorted by profitability (net profit margin) and the average cost of production for certain items is calculated for the group as a whole as well as the 10 most profitable and 10 least profitable producers.

Feed cost is not the only statistically different cost difference between the top 10 and bottom 10 profitability categories. The top 10 most profitable producers also enjoy lower labor and management costs ($11.40 vs. $19.32) and lower costs for other operating expenses ($6.51 v. $9.43) such as utilities, fuel, and veterinary expenses. These differences are statistically significant with p-values just under 0.10. The top 10 category also has lower costs in the other areas, but the differences with the bottom 10 category are not statistically significant at the 10 percent level.

The results indicated that the best performing producers (those with the highest profits) tend to have lower production costs than other producers. Moreover, the lower costs of production

are driven primarily by lower feed costs. Of secondary importance are lower costs for labor and management and also lower other operating expenses (e.g., veterinary costs, utilities, and fuel).

2.8.3.2 Price and Production Measures

Finding from the research showed that none of the market prices paid or received by the producer categories are statistically different across the groups. While the top 10 producers received slightly higher prices for their market hogs ($59.41 vs. $54.62), they received lower prices for cull animals ($31.68 vs. $33.37). These results are somewhat surprising as it is often asserted that successful agricultural producers are those that excel in marketing and pricing their output. This does not seem to be a factor among niche pork producers.

2.8.3.3 Efficiency Measures

The efficiency measures can differ markedly across top 10 and bottom 10 profitability categories. Of the efficiency measures considered, the most profitable producers are characterized by the following characteristics significant at the 10 percent level. First, the most profitable producers have more 0.44 more litters weaned per sow per year than the least profitable producers. Second, the top 10 producers total herd death loss is just two versus six percent for the bottom 10 producers. Closely related, the top producers also have a lower death loss in the breeding herd (2% vs. 6%). Third, the total feed conversion ratio for the most profitable producers (3.56) is markedly lower than that of the bottom 10 profitability group (4.63). While only marginally statistically significant (p-value = 0.11), the top 10 producers also have notable advantages in pigs per litter (6.99 versus 6.24) and in labor hours per unit of output (0.79 vs. 1.29). The top 10 producers have an efficiency advantage in all measures with the lone exception of death loss from birth to weaning. This is fairly strong evidence that production efficiency is a key determinant of profitability in niche pork production.

The top 10 most profitable producers are characterized by production efficiency: greater output with the same amount of input. In particular, they have statistically significant advantages in managing the sow herd (more litters per sow per year and less death loss) and in finishing market hogs (feed conversion). These efficiencies may arise from management skill, experience, or the scale of operations. These characteristics are explored in the next section.

2.8.3.4 Scale and Size Measures

Efficiency advantages may accrue to those producers with the greatest scale or size of production. The categorical analysis is extended to measures of scale and size by examining the

following factors: total pork produced, market hogs sold, average sow inventory, and the average weight of market hogs sold. In Table 5, there is no statistically significant difference between measures of scale for the top 10 and bottom 10 profitability groups. Indeed, the top 10 producers are actually smaller than the bottom 10 producers by every measure. For instance, the average sow inventory for the most profitable group is 58 while it is 95 for the least profitable group. So, by itself, the size of the operation or scale economies is not a hallmark of profitability. This is somewhat counter-intuitive; but as pointed out by Stender et al. (2008a), it may reflect management intensive nature of niche pork production as opposed to the capital-intensive nature of conventional production methods.

2.9 Government Policies

Government Policies and intervention in the swine industry drive the success of commercial swine farming. Inefficient government support regarding international trade and importing of pork poses a threat to the South African pork industry. The pork industry faces challenges of cheap imports and dumping of pork in the South African market (Louw, 2011). Louw (2011), further opined that South African farmers cannot afford to produce at lower prices as farmers in the other subsidized countries. The policy poses a threat to the South African swine farmers. Swine farmers are faced with high feed prices resulting from imports of commercial feed ingredient and veterinary supplies.

2.10 Transport Duration and Distance

Pigs in Canada are usually transported at least once in their life, either as young piglets, when transferred to grow-finish facilities, or as older pigs when being sent for slaughter. Gilts and boars are also transported from genetic nucleus sites to commercial farms (McGlone et al., 2014). The welfare of pigs during transportation depends on many interacting factors, such as the condition of the animal at time of loading, ambient temperature, loading density, time in transit, social stress (e.g., mixing with unfamiliar pigs), handling, unfamiliar noises and smells, vibrations, and sudden speed changes (Bench, Schaefe &, Faucitano, 2008; Lambooij, 2014). These factors are potentially stressful and, in combination can also have a significant impact on the pigs' physiology, resulting in meat quality defects at slaughter. The term stress is used frequently throughout this review as a way of suggesting negative implications (defined as acute or chronic stress) on pig welfare during transportation.

Loading is generally considered the most critical stage of the transport period, mostly in terms of physical and psychological challenge, as shown by increases in heart rate (Correa et al, 2010,

& Correa et al, 2013), body temperature (Goumon et al., 2013; Conte et al., 2015), and blood cortisol and lactate values (Edwards et al., 2010; Ritter et al., 2009; Bradshaw et al., 1996). These responses to transport stress are not only indicators of reduced welfare but may also have an effect on *peri-mortem* muscle metabolism and thereby on meat quality. Stress at loading can result from factors, such as mixing unfamiliar pigs, distance moved from the pen to the loading point, group size, handling system, design of the alleys, light and sound, the handling skills of personnel, and design of the loading device [either ramp or quay/dock; (Goumon et al., 2017)]. Vehicle design features, such as the loading system (ramps or hydraulic platform), microclimate control, and floor type can also impact the welfare of pigs during transport (Faucitano et al., 2018).

The types of vehicles used for pig transportation in Canada vary from small single-deck trucks to large three-deck punch-hole trailers, with either "pot-belly" or straight/flat-deck designs. Pot-belly trailers are widely used as they are versatile and can transport large loads (up to 230 slaughter-weight pigs) in a single journey (Correa et al, 2013 & Correa et al, 2014). However, they have been criticized because of difficulties in handling pigs due to the need to negotiate multiple internal ramps and turns (Torrey et al, 2013, & Torrey et al 2013) and poor internal climate conditions (Brown et al., 2011; Weschenfelder et al., 2012; Weschenfelder et al., 2013; Fox et al., 2014). These internal conditions can either result in a higher percentage of pigs showing open-mouth breathing and skin discoloration at unloading, or greater animal losses and poor pork quality when compared with other trailer designs (Ritter et al., 2008).

In Canada, the large expanse of the territory coupled with the consolidation of the slaughter industry results in pigs being transported for long distances and durations >7 h (Goumon et al., 2013; Bench et al., 2008; Weschenfelder et al., 2012).

Indicators of poor welfare have been reported in slaughter pigs for both long and short journeys (Werner et al., 2007; Haley et al., 2008). According to Warriss (1998), a short transport under poor conditions may compromise welfare as much as, or even more than, a long transport under good conditions. Some studies present evidence that shorter transport distances (<100 km) may be more detrimental resulting in a higher number of dead on arrival (DOA) than longer ones as the stress of loading and unloading over a short period of time is compounded. In contrast, on long journeys under suitable conditions, pigs are able to recover from the stress of loading and have time to acclimate to transport before unloading (Bradshaw et al., 1996, Tarrant 1989, Stephens et al., 1990; Bradshaw et al., 1996; Gosálvez et al., 2006; Barton-Gade

et al., 2007; Sutherland et al., 2009). It has been observed that pigs increasingly began to sit and lie down after 20–30 min of transport, indicating that pigs are more vulnerable to fall or be thrown around due to vehicle movements during the initial period of transport when they are more likely to be standing up (Nannoni et al., 2016).

Haley et al. (2008) found that for every 50 km increase in distance, transport mortality decreases by 0.03%, and in-transit death losses were lower for transport distances >135 km. However, in this study there were large differences in mortality risk between producers (94% of the producers had no deaths). It is possible that there were confounding factors between producers and distance to the slaughter plants (i.e., some of the producers with high mortality may have been located closer to the slaughter plants than those with a lower mortality). Thus, to confirm these results, controlled studies, where the farm (or herd) and travel distance factors are blocked, are needed. Rearing conditions and pre-transport management also accounted for some of the difference in DOA between producers. Sutherland et al. (Sutherland et al., 2009) reported a positive linear relationship between mortality risk for pigs transported to slaughter in the USA and increases in journey duration from 0.5 to 4 h. Although, they reported that the risk then decreased as journey duration increased from 5 to 10 h, the regression coefficient was positive rather than negative, suggesting that the mortality risk actually increased with journey duration. Averós et al. (2008) used multivariable analyses to identify risk factors for mortality of pigs transported to slaughter in the EU. There was an interaction between the duration of pre-transport fasting and journey duration. For journeys up to 8 h in pigs that had not been fasted, the risk of mortality increased with journey duration, but in those that had been fasted, there was no effect of journey duration (of up to 24 h) on mortality risk.

Short journeys (2 h and less) result in increased concentrations of cortisol and lactate in exsanguination blood, resulting in higher risk of pale, soft and exudative (PSE) pork (Fortin, 2002; Pérez et al., 2002), and in pigs being more difficult to handle at the slaughter plant (Grandin, 1994). During short transportation trials (45 min), using both pot-belly and flat-deck trailers (Weschenfelder et al., 2013) reported an increased level of fatigue (based on exsanguination blood lactate level) at the time of slaughter in pigs hauled with the pot-belly trailer. The authors concluded that the pigs transported for such a short time did not have sufficient time to recover from the stress of loading in the pot-belly trailer due to internal ramps and turns.

However, there is also evidence that pigs transported for long durations (>16 h) may be more exposed to fatigue and dehydration, as shown by the higher blood glucose, lactate and hematocrit levels at slaughter (Brown et al., 1999; Mota-Rojas et al., 2006; Becerril-Herrera et al., 2010). When compared to 6 and 12 h of transport in winter, Goumon et al. (2013) and Sommavilla et al. (2017) reported that pigs, which were transported for 18 h, had greater gastrointestinal tract temperatures, higher exsanguination blood volume, and drank more water and took longer to rest in the lairage pen. In a study investigating the transportation of fattening pigs in Mexico (Mota-Rojas et al., 2006), transported fattening pigs for 8, 16, and 24 h without access to feed or water. The authors reported increased incidence of bruising, redness of the skin, muscle tremors, and number of pigs lying down upon arrival at the slaughter plant in pigs transported for the longest time (24 h).

However, it is likely that the additive effects of vehicle design, fasting duration, mixing, ambient, and transport conditions, and pig genetics make significant contributions to the relationships between journey duration and risk of fatigue and exhaustion of muscle glycogen stores (Weschenfelder et al., 2012; Weschenfelder et al., 2013; Salmi et al., 2012; Goumon et al., 2013; Scheeren et al., 2014; Brandt et al., 2015).

There are few studies in the literature which focus on the effects of transport duration on newly weaned pigs or breeding pigs. Sutherland et al. (2012) assessed the effects of 0, 6, 12, 18, 24, or 30 h of transportation on the well-being of breeding-age gilts using multiple indices of stress (including granulocyte to lymphocyte ratio (G:L), blood cortisol level, metabolic homeostasis, muscle exertion, and reproductive performance) under USA transport conditions. In this study, non-transported gilts (control) remained in their home pen and had access to food and water during the entire experimental period. The study found that gilts transported up to 30 h experienced acute stress during the initial 6 to 12 h, while having changes in water homeostasis throughout the 30-h journey due to dehydration and food deprivation. The G:L ratio was greater in the transported gilts after 6, 12, and 18 h of transportation than in control (non-transported) gilts. Blood cortisol concentrations were also greater among the transported gilts after 6 h compared with non-transported gilts. In animals transported for 12 and 30 h, blood cortisol, G:L ratio, and cytokine levels were all within baseline levels.

However, an increase in blood albumin and total protein suggests that pigs were experiencing dehydration.

Overall, there appears to be a growing body of literature that supports the view that short as well as long transportation times can concentrations be detrimental to animal welfare, although the information about animal losses, including dead and non-ambulatory pigs on arrival at the plant, was not recorded in most reviewed studies (Goumon et al., 2013; Weschenfelder et al., 2012; Weschenfelder et al., 2013; Fortin, 2002; Pérez et al., 2002; Brown et al., 1999; Mota-Rojas et al., 2006; Becerril-Herrera et al., 2010; Sommavilla et al., 2017; Sutherland et al., 2012). The length of journey does not appear to be the most important factor in terms of pigs' response to transport; other transport factors (e.g., weather, driving technique, stress susceptibility, vehicle design, location within the truck, and pig health) also play an important role in the animals' response (Goumon et al., 2013; Weschenfelder et al., 2012; Weschenfelder et al., 2013; Tarrant, 1989; Goumon et al., 2013; Vitali et al., 2014). However, longer duration transports have the added limiting factor of prolonged time off feed and water, especially considering that fasted pigs must rely on body energy reserves to survive and cope with transport and handling stress.

Dead and non-ambulatory pigs at the processing plant are a multifactorial problem that can be influenced by pig, facility design, people, management, transportation, processing plant, and environmental factors (Anderson et al., 2002; Ellis et al., 2003; Ellis & Ritter, 2005a), and these losses represent multiple challenges for the entire US food chain. First, improving the welfare of finished pigs during transport and reducing the incidence of dead and non-ambulatory pigs has become an animal welfare priority (National Pork Board, 2007). Second, increasingly strict rules, regulations, and enforcement are being considered for non-ambulatory livestock [e.g., the Downed Animal and Food Safety Protection Act—Bill H. R. 661 (US House of Representatives, 2007) and Bill S. 394 (US Senate, 2007)]. Third, transport losses represent direct financial losses to pig producers and pork processors. Dead and non-ambulatory pigs have been estimated to cost the US pork industry $50 to $100 million annually (Ellis et al., 2003). In 2004, the Animal Welfare Committee of the National Pork Board sponsored a workshop that involved scientists, government officials, and industry representatives from North America and Europe to review the scientific literature pertaining to transport losses in market weight pigs. The goals of this workshop were to identify key gaps in current knowledge and to identify future research needs.

The term “transport losses” refers to pigs that die or become non-ambulatory at any stage of the marketing process, defined as movement from the grower-finisher environment to stunning at the abattoir. Pigs that die during transport are referred to as “dead on arrival,” whereas pigs

that dies after having been unloaded are termed “dead in yard” or “dead in pen.” These loses contribute greatly to the profit that accruable to the producer/farmer. A “non-ambulatory pig” is a pig unable to move or keep up with its contemporaries at the processing plant (Anderson et al., 2002). Several terms are used throughout the industry for non-ambulatory pigs, including cripples, slows, stressors, subjects, and suspects. Two types of non-ambulatory pigs commonly observed are fatigued and injured pigs (Ellis & Ritter, 2005a, b). “Fatigued pigs” are pigs that, without obvious injury, trauma, or disease, refuse to walk or keep up with their contemporaries at any stage of the marketing process (Ritter et al., 2005). In addition, “injured pigs” are those that become non-ambulatory or that have a compromised ability to ambulate because of structural unsoundness or an injury sustained before or during the marketing process (Ellis & Ritter, 2005b).

When transporting live animal like swine farmers should ensure they have the necessary permits, otherwise the swine might be confiscated along the route which will add to the loss. In other to avoid disease entering the far, farmers are advised not to sell to travelling speculators who goes from farm to farm to buy swine.

2.11 Government Subsidy

Animal agriculture in general and pig production in particular are important economic activities globally (Dietze, 2011; Mokoele et al., 2015; Roelofse, 2013). In South Africa, swine production is distributed in all nine provinces, with higher concentrations in Limpopo, North West, Gauteng and KwaZulu-Natal, partially because of cultural and religious preferences and availability of feedstuffs. Free State is placed sixth in terms of swine production, contributing approximately 8% of the national pig herd (DAFF, 2016; MPG, 2013). The province had a relatively high concentration of small-holder pig farmers otherwise known as emerging small-scale pig farmers. Swine farming requires little space, yields a large number of offspring after a shorter gestation period than other small stock and can be combined with other forms of subsistence agriculture where land resources are scarce (DAFF, 2016; Makiwane et al., 2012). In addition, it plays a major role in poverty reduction and food security (FAO 2004) and provides a form of investment, emergency cash and meat for home consumption (Drucker & Anderson, 2004; Mhlanga, 2002). In Free State Province, the commonly found breeds of pigs are the Kolbroek, Large White, Landrace and their crosses.

Backyard pig farming and semi-intensive management systems in poorly designed pens are the most common small-holder pig farming practices in the rural and peri-urban areas of Free State.

In general, the farm families rely on family labour and the majority of products are meant for household consumption or converted to cash for the purpose of family maintenance. The Free State Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA) established the programme called *Masibuyele esibayeni*, meaning *back to the kraal* (i.e. returning to the land), with similar programmes in Gauteng, Mpumalanga and Limpopo amongst others. The programme is aimed at helping the small-holder farmers to upgrade and boost productivity by improving the genetic pool of their livestock. For the pig component, DARDLEA provides farmers with 10 sows and 1 boar with improved genetics for breeding and provides supportive services to such farms.

2.11.1 Government Grant, Incentives, and Funding Available to Farmers in South Africa

Whether newly entrant into the agribusiness sector, or already operating a farm, funding remains one of the top concerns for starting and growing an agribusiness.

Fortunately, the South African government has prioritized the growth of irrigated land production and agriculture, as well as developing industries such as agro processing, fisheries and small enterprises in the National Development Plan.

There are various grants, funding and incentives that have been made available by the government in an effort to assist new entrants and existing farmers in developing agriculture. They include:

(a) Agricultural government grant
(b) Agricultural government funding
(c) Agricultural government incentive programme
(d) Agricultural government grant: This is the awarding of financial assistance to your agribusiness. Grants generally don't need to be paid back by the recipient. However, there will be specific criteria for determining who will be eligible for a grant and once awarded, strict guidelines around what the fund can be used for.

(a) Agricultural government grant

A list of the government grants available to the agricultural sector is presented as follows:

Land Redistribution for Agricultural Development (LRAD): The LRAD programme was developed to support previously disadvantaged citizens to buy both land and agricultural equipment specifically for the purpose of an agribusiness. The LRAD grant is a non-refundable financial contribution from government.

Capital requirements: This grant only supplements farmers' existing funds to support them in growing their agribusiness. They need to have some kind of capital contribution to begin with. Cash contributions can be a minimum of R5000, which will qualify them for a minimum grant of R20 000, and a maximum of R100 000, which will qualify them for a maximum grant of R400 000.

The farmers contribution doesn't have to be cash only. Agricultural assets integral to their operation can be counted as contributions. The total monetary value of these assets will be calculated to determine their contribution amount. Payments still outstanding on financed assets will not affect their contribution amount – the full value of the asset will be taken into consideration. Examples of assets that were considered include:

- Property
- Machinery
- Equipment
- Livestock.

Land that you obtained through a previous grant, restitution, tenure security grant or donation cannot be used as your own contribution.
Labour can also be considered as part of thier contribution, but the labour units can only be equated to a maximum of R5 000 of their own contribution.

2.11.2 Sector Specific Assistance Scheme (SSAS)

The SSAS is a reimbursable cost-sharing government grant that can be applied to the agricultural sector, where financial support is given to business that are supporting the development of industry sectors and businesses contributing to the growth of SA's exports. The objectives of the SSAS agricultural government grant are to:

- Develop entire industry sectors.
- Develop new export markets.
- Improve employment opportunities.
- Expand the export base.
- Develop solutions to inhibitors of export growth.
- Promote comprehensive participation of black owned business and SMME's to the economy.

Funding requirements

This agricultural government grant is divided into three subsections:

Generic funding – R50 000 grant for establishing an export council. This grant can be used for marketing, advertising and publicity costs on a 2:1 ratio, reaching a maximum of R1 million.

Project funding – 80:20 cost-sharing grant for projects that are enhancing eligible sectors, like agriculture, identifying new export markets and promoting black SMME's, women, youth and people with disabilities. Project funding for emerging exporters – Costs of travel, accommodation, exhibition costs, transportation of samples and marketing material will be covered to a maximum of R1.5 million.

SSAS projects objectives

These projects have a specific task that can be pre-determined and have a specific short-term time period and measurable milestones. They are developmental or promotional in nature, which means they uplift your sector and highlight your business and SA as a good export partner.

These projects can benefit the entire sector by promoting SA's products internationally. The SSAS also funds non-profit businesses in your sector and sub-sector to uplift the entire sector.

(b) Agricultural government funding: Agricultural government funding is typically when a project or business derives part or all of its financial support from government. This funding needs to be repaid after a specific period of time, which is agreed upon by both you and the government. Here are some of the government funding options available to the agricultural sector:

Isivande Women's Fund (IWF)

The Isivande Women's Fund funds the improvement of women's economic empowerment in the agricultural sector. This fund is specifically aimed at businesses that require:

- Start-up funding
- Business expansion
- Business rehabilitation
- Franchising
- Bridging finance.

The fund specifically supports the development of self-sustaining women-owned business within South Africa by offering these businesses primary financial and non-financial support.

Strategic Business Unit (SBU): Agri-business and agriculture

The aim of this agricultural funding opportunity is to develop competitive processed food, beverage, fibre, and forestry and derivative industries.

This applies to industries that specifically use and develop local and regional resources that supply domestic demand, as well as increase participation in international trade. These businesses intend to achieve this by expanding the capacity of production and encouraging value adding expansionary which will lead to an increase in processing activities.

This agricultural funding opportunity is eligible to a wide range of economically viable businesses in the agro-processing sector like:

- Maize
- Wheat and sugar
- Livestock such as cattle, poultry, pigs and game
- Fishing and aquaculture
- Beverages
- Forestry
- Horticulture including fruit, vegetables, nuts, tea and coffee.

The purpose of the fund

The outcomes for this agricultural funding programme are to fund and support development activities and have the following impact on South Africa's economy:

- Promotion, expansion and extension of new and existing industries. Resulting in the creation and preservation of employment prospects as well as driving sustainable economic growth opportunities.
- Enabling local industries to better utilise resources and infrastructure.
- Enabling local industries to enhance operating margins as well as improve and maintain competitiveness.

Land Bank

The Land Bank provides financial services to the commercial farming sector. It was created by government for the specific purpose of financing, agri-business as well as financial products that would promote new entrants into the agriculture industry.

Products and services

The Land Bank offers the following products and services to the commercial farming sector:

- Long Term Loans
- Medium Term Loans
- Short Term Loans
- Deposits
- Guarantees
- Establishment Loans
- Large Live Stock
- Instalment Finance
- Special Mortgage Loans

The South African development finance institution serves all farmers equally.

(c) Agricultural government incentive programme: A government incentive is an incentive programme that is offered by various government departments. These incentives are used to stimulate and assist sustainable, competitive development within industries. This is accomplished by offering accessible incentives that can successfully improve national priorities. There are several programmes that support development and growth of commercially viable and sustainable business opportunities along with incentives specific to funding or tax relief. Incentive programmes aim to ensure the creation of new and sustainable jobs.

Government incentives were created to increase the level of participation in certain developing areas that may have otherwise been too costly for businesses. The Department of Trade and Industry has several incentive programmes but various other government departments also offer own incentive programmes. The following are government incentives offered that are not specific to the agricultural industry but are applicable to agribusiness:

Business Process Services (BPS)

The BPS government grant was developed to attract new investments from international businesses in a bid to create additional employment opportunities in South Africa. This specific grant has already created 9077 new jobs and has had an annual growth rate of 26% over the last three years.

The purpose of the incentive

The primary objective of the BPS government grant is to create jobs through servicing offshore business. Its secondary objectives are:

- To create youth job opportunities.
- To contribute to the export revenue of the country using offshoring services.

The benefits of the BPS government grant are:

- Incentives are calculated based on projected international employment created.
- Incentives are offered on a two-tier structure for non-complex and complex jobs.
- Incentives are paid for five years from the date the offshore job is created.
- Incentives are determined at application stage, depending on fully loaded operational costs.
- A bonus incentive is paid at the end of the five-year period.

2.11.3 Aquaculture Development and Enhancement Programme (ADEP)

This agricultural government incentive programme offers businesses a reimbursable cost-sharing grant of up to R40 million. The ADEP is available to companies that are engaged in the primary, secondary or ancillary aquaculture activities within both marine and freshwater options.

The ADEP agricultural government incentive programme's objectives are to:

- Increase your production.
- Sustainable and creation of job opportunities.
- Encouragement of the geographical spread of companies throughout South Africa.
- Broadening of participation throughout the sectors within South Africa.

The purpose of the incentive

ADEP offers a reimbursable cost-sharing grant of up to R40 million as part of its incentive programme, which specifically covers:

- Machinery
- Equipment
- Bulk infrastructure
- Owned land/or buildings

- Improvements on leases
- Activities to improve competitiveness.
- Applying for government funding can be a difficult process, however should your businesses application be successful the necessary funding and business support will go a long way to starting the business of your dreams, or growing your existing farm into a sustainable agribusiness.

Applying for government funding can be a difficult process, says Nicole (2015) however should your businesses application be successful the necessary funding and business support will go a long way to starting the business of your dreams, or growing your existing farm into a sustainable agribusiness.

Production Cost

A study was conducted to compare the profitability of three pig production systems; (1) feeder-pig system, (2) pig-finishing system and (3) farrow-to-finish system. The three systems are practiced under the Smallholder Improvement Management System in Ntcheu District of Central Malawi. Simple random sampling was used to collect data from 90 households. The data was subjected to gross margin analysis, net profit margin analysis, return on investment (ROI) and correlations to determine and compare the profitability among the three systems.

All the three systems registered positive gross margins ranging from K6093 per pig for the pig-finishing system to K20842 per pig for the farrow-to-finish system. A comparison of the gross margins among the three systems showed that there were significant differences at the five percent level. When net profit margins were computed, the results showed that there were no significant variations in the way the farmers-controlled overheads. The results also showed that farrow-to-finish system had the highest ROI of about 61 percent. Additionally, the results showed that there was a positive correlation between selling slaughtered pigs on both gross margins and ROI. Therefore, farmers who want to go into pig farming are encouraged to adopt any of the three enterprises depending on their capital requirements and risks associated with the enterprise.

All the three pig production systems are profitable. This is evidenced by the positive gross margins and net profit margins across all the enterprises. However, there are significant differences in the profitability of the three enterprises. From the results, farrow-to-finish system is more profitable than feeder pig production and pig finishing systems. Results on return on

investment also revealed that farrow-to-finish has the highest return on capital employed. However, the results of ROI also showed that there is no significant difference in ROI between feeder pig system and pig finishing system. While farrow-to-finish and feeder pig systems can break-even with one sow but with different numbers of required sellable units, feeder pig system requires 8 weaners to break even. It was also observed during the study that the farmers in the area faced some challenges. There was lack of reliable markets, lack of cooling and storage facilities and high cost of weaners. Despite these challenges, farmers who wish to go into pig farming can adopt any of the three pig production systems as they are all profitable. The choice as to what system a farmer should adopt will depend on the initial investment costs and individual farmer's risk preference.

2.12 Membership of Swine Organization

South Africa has some known swine organizations that are approved and recognized by the government. The major player in the industry is the South Africa Pork Producers Organization (SAPPO). SAPPO has other affiliated bodies which includes:

(a) Natal Pork Producers' Organization
(b) Western Cape Pork Producers' Associatin
(c) Free State Pork Producers' Organization
(d) Premier Pork Producers.

There are other organizations that exist in the country that could be assessible to the swine producers. The organizations include:

(1) Free Range Pork Association
(2) Pig Vetenary Society
(3) Pig Breeders' Society of South Africa
(4) Red Meat Industry Forum

These associations/organizations have in one way or the other contributed to growth of pig farming in South Africa. The challenge is that most of the rural pig farmers do not have adequate information about them.

2.13 Pork - The Product Itself

Pork is at present the number one source of animal protein in the world today, accounting for no less than 40 percent of world meat consumption. Pork is regarded as a consumer product, since it is purchased for personal and/ or family consumption. According to Schonfeld (2001)

the nutrient content of pork can be regarded as a good source of protein, iron, zinc, as well as a good source of almost all the Vitamin Bs and an excellent source of thiamine. The protein in pork is complete and also contains all nine essential amino acids required for normal body growth. A fundamental challenge in a product's development is the translation of consumer demands and preference into physiological aspects of the product. The unenviable challenge for the producer and processor is thus to ensure that the end product exhibits high quality when purchased (expected quality) and equally good quality when consumed (experienced quality). Pork may be cooked from fresh meat or cured over time. Cured meat products include ham and bacon. The carcass may be used in many different ways for fresh meat cuts, with the popularity of certain cuts and certain carcass proportions varying worldwide. Most of the carcass can be used to produce fresh meat and in the case of suckling swine, the whole body of a young swine ranging in age from two to six weeks is roasted. Danish roast pork, prepared with crispy crackling is a national favourite and the traditional Christmas dinner.

Pork is particularly common as an ingredient in sausages. Many traditional European sausages are made with pork, including chorizo, fuet, Cumberland sausage and salami. Many brands of American hot dogs and most breakfast sausages are made from pork. Ham and bacon are made from fresh pork by curing salt (pickling) and/or smoking. Shoulders and legs are most commonly cured in this manner for picnic shoulder and ham, whereas streaky and round bacon come from the side.

Ham and bacon are popular foods in the west, and their consumption has increased with industrialization. Non-western cuisines also used preserved meat products. For example, salted preserved pork or red roasted pork is used in Chinese and Asian cuisine. Bacon is defined as any of certain cuts of meat taken from the sides, belly or back that have been cured and/or smoked. In continental Europe, it is used primarily in cubes as a cooking ingredient valued both as a source of fat and for its flavour. In Italy, besides being used in cooking, bacon is also served uncooked and thinly sliced as part of an antipasto. Bacon is also used for barding roasts, especially game birds. Bacon is often smoked, using various types of wood, a process which can take up to ten hours. Bacon may be eaten fried, baked, or grilled.

2.13.1 Pork Consumption Patterns

Pork is one of the widely eaten meats in the world, accounting for about 38% of meat production worldwide, although consumption varies widely from place to place (Raloff, 2003). Although to the UDSA's Foreign Agricultural Service, nearly 100 million metric tons of pork was

consumed worldwide in 2006. Increasing urbanization and disposable income has led to a rapid rise in pork consumption in China, where 2006 consumption was 20% higher than in 2002, and a further 5% increase projected in 2007.

Table 2.7 Foreign Agricultural Service, preliminary data for 2006.

Rank	Region	Metric tons/millions	Per capita/Kg
1	People's Republic of China	52.5	40.0
2	EU25	20.1	49
3	United States	9.0	29.0
4	Russia	2.6	18.1
5	Japan	2.5	19.8
	Other	12.2	N/A
	Total	98.9	N/A

Source: USDA Foreign Agricultural Service, preliminary data for 2006.

2.13.2 Pork Products and Co-Products

Although pork is now the most widely consumed meat in the world, other products are yielded from processing a pig. Pork co-products used today include insulin for regulation of diabetes, valves for human heart surgery, suede for shoes and clothing, and gelatin for many food and non-food uses. In addition, swine by-products are used in water filters, insulation, rubber, antifreeze, certain plastics, floor waxes, crayons, chalk, adhesives, and fertilizers. Manure is the largest co-product of swine production by volume.

2.14 Breeds of Swine and Breeding Systems

The definition of breeds can be described as somewhat elusive because of different interpretations of the criteria that establish a breed. A classic definition of breed from a genetic standpoint is often described as "Animals that, through selection and breeding, have come to resemble one another and pass those traits uniformly to their offspring". Unfortunately, this definition leaves some unanswered questions. Lush (1994) in his book "The Genetics of Population" explained why the definition of breed is elusive. He defined breed as a group of domestic animals, termed such by common consent of the breeders, a term which arose among breeders of livestock, created one might say, for their own use, and no one is warranted in assigning to this word a scientific definition and in calling the breeders wrong when they deviate

from the formulated definition. It is their word and the breeder's common usage is what we must accept as the correct definition.

The most commonly recognized breeds used in modern swine production units include the Berkshire, Chester White, Duroc, Hampshire, Pietrain, Landrace, Meishan, and Yorkshire (Large White). Because genetic selection practices differ among countries, traditional breeds have undergone genetic change and are now identified with a country of origin attached to the original breed name. An example is the American Landrace, Danish Landrace, and Finish Landrace breeds that have all been genetically selected over many generations to excel in traits that are important within a respective country.

Many breeds of swine are commonly raised in Pennsylvania. Each breed has characteristics that distinguish it from other breeds of swine. Swine producers choose to raise a particular breed of swine instead of another breed because that breed has a combination of qualities that producers want to have in their herds. For example, swine from white breeds usually make good mothers, while swine from colored breeds usually make good sires when crossbreeding.
Some of the major breeds of swine rose in Pennsylvania and their characteristics are listed below:

Berkshire: Originated in England. The ears are short and erect. The body is black with white feet, tail and white spot on the head Known for high quality pork, tender, juicy and flavourful meat.

Duroc: Originated in the United States. Durocs are solid red in color, with the red ranging from light to very dark. The ear carriage is down and often described as droopy. Duroc is widely used as a sire breed and is known for a high rate of lean growth, efficient conversion of feed to lean tissue and extremely high-quality pork products.

Chester White: Originated in the United States. Chester White hogs are solid white in color with small, downward pointing ears. The Chester White is known for prolificacy and mothering ability.

Hampshire: Originated in England. Hampshire is black in color with a characteristic white belt starting behind the neck and extending a short distance across the back. Ears are generally upright. The Hampshire is a popular terminal sire, known for its lean, muscular carcasses.

Landrace: Originated in Europe. Landrace are solid white in color and generally have long, drooping ears that cover a portion of the face. Landrace are known for their mothering ability and prolificacy, but are also selected for leanness and muscle in many countries of the world. Many breed strains exist within the Landrace population, including: American Landrace, Belgian Landrace, Dutch Landrace, Finnish Landrace, French Landrace, German Landrace, Italian Landrace and Swedish Landrace.

Pietrain: Originated in Belgium. Pietrains are predominantly white, with black spots that vary in intensity due to variation in pigment content. Pietrains have been selected for extremely lean carcasses with large volume of muscle. They are used primarily as a terminal sire breed throughout Europe.

Meishan: Originated in China. The Meishan is predominantly black in color, with large ears and very wrinkled skin. They are characterized as fat, slow growing pigs with good pork quality. They are primarily known for their extreme prolificacy and resistance to some disease-causing organisms. The Meishan has been extremely important as a model for improving reproductive capacity of the modern pig.

Yorkshire (Large White): Originated in England. The Yorkshire and Large white names are considered by most people to be synonymous, with Large White being the internationally recognized name. Yorkshires are entirely white, with ears that are erect and moderate in size. Yorkshires are recognized worldwide as the mother breed due to their prolificacy and mothering ability.

Many additional breed resources continue to be propagated throughout the world. Many of these breeds are considered 'minor' breeds due to limited numbers and often a lack of a breed society to ensure breed purity. The people's Republic of China is home to an extensive group of pig breed resources estimated to number more than 100 in total.

2.14.1 Purebred Breeding Systems

Producers who raise purebred swine often utilize artificial insemination in order to capture the best genetics available. Semen from purebred boars is available from many commercial boar studs around the country. Good purebred breeders pay attention to many factors when selecting breeding stock performance data, structural correctness, muscling and leanness are

the most important. In the past, when many producers marketed a few pigs, it was relatively easy to sell purebred breeding stock to other producers. Most large commercial producers buy purebreds from commercial breeding stock companies. If you choose to raise purebreds, buy the best ones you can afford. Purebreds also offer the opportunity to show (and sell) breeding stock at various county, regional, and state shows.

Table 2.8 Oklahoma State Swine Breeds Directory

Breed	Description
Berkshire	Black with white on the face, legs, and tail. Erect ears.
Chester White	White with small, partially drooping ears.
Duroc	Red with partially drooping ears. Muscular. Good sires.
Hampshire	Black with a white belt. Muscular. Good sires.
Landrace	White with large, drooping ears. Very long-bodied. Good mothers.
Poland China	Black with white on the face and legs. Partially drooping ears.
Spotted Swine	Black and white spotted. Partially drooping ears.
Yorkshire	White with erect ears. Long-bodied. Good mothers.

Source: Oklahoma State Swine Breeds Directory, http://www.ans.okstate.edu/breeds/swine

2.14.2 Crossbreeding Breeding Systems

Crossbred pigs have some advantages over purebred pigs because of a genetic phenomenon called heterosis (also known as hybrid vigor). Because of heterosis, most commercial swine producers use crossbred pigs rather than purebreds. What is heterosis? Heterosis usually gives crossbred pigs an improvement over the average of its parent purebreds in a certain trait. For example, if the average litter size for a herd of Yorkshire purebreds was 11 and average litter size for a herd of Hampshire purebreds was 9, we would expect the average litter size of Yorkshire x Hampshire crossbred sows to be 10 pigs. In reality, the average litter size might be closer to 11.5 pigs, which is higher than either of the parent breeds. Improvement of the actual litter size over expected litter size is a result of heterosis.

Generally, heterosis affects reproductive traits relatively more than growth and carcass traits. Heterosis affects several important reproductive traits in pigs. In addition to improvement in litter size, crossbred sows usually produce more milk, eat more, and farrow more vigorous pigs than purebred sows. There are several planned crossbreeding systems that producers commonly use. Pure breeds for crossbreeding systems are selected for their ability to add some

trait to the final crossbred market hog. For example, a white breed such as Landrace or Yorkshire is usually included in the crossbreeding system for their maternal traits (number born alive or milking ability). A colored breed such as Duroc or Hampshire is normally included for its growth rate, feed efficiency, or carcass traits. A planned crossbreeding system may include as few as many as four breeds.

2.14.3 Swine reproduction and breeding

Sows and gilts can be bred either naturally or artificially. Your facilities, time, and number of sows or gilts can determine which method you use. A sow's cycle averages 21 days, but can be as short as 18 days, or as long as 23 days. This means the sow should be in heat, or receptive to mating roughly every 3 weeks. During most of the cycle, follicles are developing on the sow's ovaries. Each follicle will ovulate one egg. Twelve to 15 follicles (or more) develop on each ovary during each estrous cycle. As the time of standing heat approaches, the follicles get larger and larger, releasing estrogen that causes the outward behavioural signs of heat you see. Each follicle ruptures, releasing an egg into the oviduct where each egg is fertilized by a single sperm.

Fertilized embryos then travel to the uterus. If the sow is successfully mated, the best indication of pregnancy is the absence of another heat period about three weeks later. Gilts normally begin estrous cycles at around five to six months of age. Often some period of stress, such as a truck ride or the fighting that occurs after mixing with strange pig, can trigger gilt's first heat. Largest litters are expected if gilts are bred on their second or third heat, but it is more advantageous if they weigh at least 280 pounds and are 7 to 8 months old. Sows in good physical condition can normally be expected to be in standing heat four to eight days after weaning. If sows are thin, it may take somewhat longer.

2.14.4 Natural mating vs artificial insemination

Natural mating is relatively simple with a boar that is aggressive, willing, and able to mate. In natural mating, the boar does the heat dictation and determines if the sow or gilt is in heat. Some producers simply leave the boar in the pen with sows and allow the boar to mate sows whenever they are in heat. Many producers practice "hand mating" where they bring the boar into a pen of sows or gilts once or twice each day to dictate sows that are in heat. Once the boar mounts a sow or gilt in standing heat, it is important to make sure that a successful mating takes place by manually guiding the boar's penis into the sow's vulva. An average mating will take five to 10 minutes after which the boar will dismount. The boar should then be removed from the pen until the next heat check or mating. For best results, gilts or sows should be hand mated at

12-hour intervals at least two services. Boars should not be used more than 5 services per week. It is pertinent to regularly use a solid hand hurdle when handling a boar. Older boars can be very aggressive and can hurt the herdsman with their teeth if adequate precautionary measures were not followed.

Artificial insemination requires more planning and preparation by the herdsman. Boar semen for AI is usually shipped fresh, not frozen, and is fertile for five to seven days after collection. For maximum conception rate and litter size, fresh semen should ideally be used within 3 days of collection. To avoid unnecessary complications, semen should be ordered to arrive sometimes months ahead of time before the heat expectancy periods of the sows. Ordering semen for sows is simpler than for gilts. The herdsmen have control over weaning time, and can expect their sow to cycle 4-8 days after weaning. Thus, farmers should plan to wean sows about four days before expecting semen to arrive. About two “doses” or vials of semen should be ordered for every so that is meant for breeding. Insemination rods are usually ordered along with the semen. Since insemination rods are disposable, it is most advisable to order one rod for each service. Rods come in several shapes. One commonly used type is spiral shaped which simulates the corkscrew shape of a boar’s penis. The end of another popular type looks like a foam marshmallow with a slight groove around the middle. Both the marshmallow and corkscrew types are connected to a flexible tube approximately 20 inches long through which the semen passes. Several “hybrids” of the two types are currently available. The type choosen is a matter of personal preference, and all the types work well.

Semen is often packaged in bottles, bags or tubes that resemble toothpaste tubes. The pointed end to the container will be sealed. Store semen in the cooler in which it came. Semen are kept in the dark as much as possible since light can damage sperm cells. Semen storage temperature should be at room temperature or slightly below. A basement is a good place to store semen until it is used. Semen are not shaken, but rather they are gently mixed, once each day. Mixing distributes the nutrients in the semen container and helps the sperm cells live longer. On the other hand, shaking or rough handling can damage sperm cells. Sows that show signs of heat are inseminated twice (12 and 24 hours, respectively) after the beginning of standing heat. For instance, if semen ordered are expected to arrive on Friday, the piglets should be weaned from the sows previous Monday. The sows are then expected to begin standing heat sometime Thursday through Sunday. For the sake of this example, let’s say she begin standing heat Saturday morning, you should breed her on Saturday evening and Sunday morning.

If you plan to breed gilts, you must have a record of at least one heat before you order semen. Then you must hope she cycles at nearly 21-day intervals, and order semen for her next expected heat. Gilts should be inseminated 12 and 24 hours after the beginning of standing heat. For example, if you expect your gilt to come into heat on a Thursday, semen should be ordered so that they can to be delivered the previous Tuesday. If the sow begins standing heat Wednesday evening, it should be bred by Thursday morning and Thursday evening, respectively.

Actual mating of a sow using artificial insemination is not difficult. The following materials should be put in place to artificially inseminate the sow: semen (stored in a small cooler at room temperature and out of light), scissors (to cut the sealed end of the semen tube or bottle), and an insemination rod. If inseminating outdoors in cold weather, towel or dishcloth is wrapped around the semen container to help maintain semen temperature until it enters the reproductive tract of the sow. If a boar is available, it should be moved to an adjacent pen. The herds man normally straddles the sow's back or leans across her back to test if the sow is in standing heat (the herd's helper can perform the act). If the sow stands still, it is a good indicator that it is in heat. It is then time to insert the tip of the insemination rod into the sow's vulva. The back end of the rod is tipped down toward the ground and the insemination rod inserted until some resistance are met. The resistance should be the cervix. If you the corkscrew type of rod is used, the rod should be turned towards the left about 2 turns or until it becomes difficult to pull the rod back out with a slight tug. If a marshmallow type of rod, it should be pushed a bit further until the rod springs back when it is lightly tugged. The groove around the marshmallow should seat itself into the interlocking rings of the cervix. While keeping pressure on the back, the semen tube or bottle should be removed from the cooler, and the sealed pointed end should be cut off. The opened semen container should be inserted into the end of the rod and twisted ½ turn to make sure it is seated properly. When bending the rod, the semen container should be lifted above the level of the sow's back so as to facilitate the flow of the semen into the sow's cervix.

The trickiest part of artificial insemination is making sure that semen flow into the sow's cervix. If the sow is in good standing heat and properly stimulated by back pressure, the contractions of its uterus should (and sometimes will) pull the semen into her reproductive tract in a matter of a few minutes. Sometimes however it takes several minutes for these contractions to begin. At this instance, patience is required. The sow's lower abdominal part should be gently stroked to stimulate the sow and semen drainage. If the semen does not seem to be flowing on its own,

the semen container should be gently squeezed and watched for semen flowing back out of the sow past the rod. Ideally, there should be no back flow. If semen is coming back out of the sow, the insemination should be stopped, the rod should be repositioned for a re-start of the process. It can take as little as two minutes for a sow to accept the semen, or as long as 20 minutes. Eight minutes is about average. When the semen container is empty, the rod should be left in the sow for another minute or two, before it is gently removed rod from the sow. A small amount of back flow is typical when removing the rod. The rod and semen bottle should be discarded, and a disposable insemination rod should never be re-used.

2.15 Chapter 2: Conclusion

This chapter focused on the history of swine production around the world and in South Africa. Also, it considered the production processes, including the breeding systems, the products, the breeds available in South Africa, and the distribution both in the South African provinces and the world.

The summary of the present-day state of livestock production systems globally in relation to recent trends, coupled with a brief assessment of whether these trends are likely to continue into the future. The key drivers underpinning past increases in livestock production were outlined, and the status of both intensive and extensive production systems in the developed and developing world is described. Also, the advances in science and technology that have contributed to historical increases in livestock production, and indicates where potential remains, in relation to livestock genetics and breeding, livestock nutrition and livestock disease management. A number of factors that may modify both the production and the consumption of livestock products in the future: competition for land and water, climate change, the role of socio-cultural drivers and ethical concerns were also considered.

According to figures from the South African Department of Agriculture, Forestry and Fisheries, pig farming in South Africa had developed into a national industry with an estimated 1,613 million pigs by 2009 (DAS, 2010). The Duroc was developed in the USA and has become important as terminal sires in many countries (Ruvinsky & Rothschild, 1998). It is the fastest growing breed in the world during the last quarter of a century. The first Duroc pigs have been imported into South Africa from Canada in 1980 primarily for cross-breeding purposes. Among the breeds commonly seen in most South African piggeries includes Large White, Landrace, Chester White, and Hampshire. Pork is produced throughout South Africa with Limpopo and

North West province taking the lead accounting for 44% of the total production (ie Limpopo 24% and North West 20%). Free State contributed 8% of the total annual production.

Sows and gilts can be bred either naturally or artificially. Cross breeding method has contributed to the increase in the production of swine In the Free State. Most of the cross bred swine through selection and breeding, have come to resemble one another and pass those traits uniformly to their offspring. Many of the swine farmers in the study area do not practice the Best Management Practice (BMPs) accepted worldwide. The purpose is to help pork producers identify BMPs that will improve their operations and reduce the potential for generating odors and release of contaminants to ground water and surface water resources. Pork producers are encouraged to individualize the BMPs to suite their operations and site conditions, and to develop their own solutions for preventing pollution. Many of the farmers visited has high density overstocking and overcrowded pen. This might have contributed to the high rate of mortality and abortion experienced in the farms.

Pork is at present the number one source of animal protein in the world today, accounting for no less than 40 percent of world meat consumption. Pork is regarded as a consumer product, since it is purchased for personal and/ or family consumption. According to Schonfeld (2001) the nutrient content of pork can be regarded as a good source of protein, iron, zinc, as well as a good source of almost all the Vitamin Bs and an excellent source of thiamine.

CHAPTER 3

SWINE MARKETING STRATEGIES

3.1 Introduction

Marketing is a crucial part of any business endeavour. However, many producers of goods/services view marketing as the great unknown, requiring a huge budget with limited accountability and measurability. Well executed strategy and planning can mean the difference between an expensive mess and a successful budget control campaign. Marketing pigs is an important aspect to profitable swine production. Pork processors have developed marketing grids that value carcasses. These grids are specific to each pork processor with premiums based on carcass weight and leanness. Although premiums depend on the pork processor, the overall trend is for processors placing more importance on carcass weight and importance on percent lean. Pigs need to be sold at an optimum weight in order to maximise profit. The mission of swine programs is to facilitate the strategic marketing of products of the swine industries in the domestic and international markets and through various programs and services, promote a competitive and efficient market place that benefit *Free State producers and consumers* (Coffey, 2013). Successful marketing is a necessary part of any profitable enterprise, and alternative marketing is often necessary for sustainable swine producers to survive.

There are many different marketing strategies for swine farm products in South Africa, like any other agricultural product, these present a number of opportunities and challenges. Farmers can either use intermediaries to market and deliver products or independently manage the steps in the distribution process. The most traditional form of distribution channel is the retail channel of distribution.

A quality farm product requires premium markets for profit maximization. Profit Maximization is a process that companies undergo to determine the best output and price levels in order to maximize its return. The company will usually adjust influential factors such as production costs, sale prices, and output levels as a way of reaching its profit goal. Profit maximization is a good thing for a company, but can be a bad thing for consumers if the company starts to use cheaper products or decides to raise prices. Smallholder farmers usually concentrate on local butchers/abattoirs and pork joints which are sometimes exploitative and have no streamlined quality standards and appreciation. These limitations are created by mostly lack of necessary quantities and quality to penetrate premium markets (Coffey, 2013).

Considering the fact that many farmers have failed due to lack of knowledge of marketing strategy. A marketing strategy is a plan that is developed with the goal to market a specific idea or product to certain consumers (Kotler & Armstrong, 2006). A swine marketing strategy is a plan developed by the farmer with the goal to market his/her produce to certain people. A successful swine producer must be a good strategist.

Considering the challenges of low sales return and profit maximization, this chapter considers the different marketing strategies that are open to Free State swine producers to profitably market their products.

3.2 The Changing Marketing Environment

No company ever function in a vacuum, therefore there are numerous forces that have impact on a company and its marketing activities. They can be divided into two groups: controllable and uncontrollable elements. *Controllable elements* are elements that come under company's influence, such as product, price, promotion, and distribution whereas, *uncontrollable elements* cannot be changed by company. These elements have strong external forces that are beyond the company's control. They include competitors, legal, politics, consumer behaviour, and etc. When a company operates in a foreign market, the management of marketing environment elements becomes especially challenging due to unfamiliar problems and unusual market behaviour. However, if it does not react to changes in the market, they will significantly affect the company's performance (Cateora & Graham, 2007; Kotler et al., 2012).

The detailed marketing environment analyses can be made by splitting the environment into three parts: the internal, the micro- and the macro-environments (Nieuwenhuizen 2007; Management Class Global, 2014; Kotler et al., 2012).

3.2.1 Macro-environment analysis

PESTLE, the acronym for political, economic, social-cultural, technological, legislative and ecological aspects of the wider environment, can be effectively applied to identify and examine various forces in the macro-environment that are currently affecting the business, and the ones that might influence it in the future (Allen, 2001). Examples of the influences, and the way they can be classified using PESTLE framework are presented in Table 1 (PESTLE analysis, 2014).

TABLE 3.1 Examples of macro-environmental forces (Strategic Management Analysis 2014)

Factors	Examples
Political factors	Trading policies, export/import policies, war and conflicts,
Economic factors	Inflation, unemployment, economic growth, interest and ex-
Social-Cultural factors	Life-style trends, buying access and trends, demographics,
Technological factors	Communications technology, R&D activities, access to the
Legislative factors	Consumer protection, taxation, employment law, insurance.
Ecological factors	Waste management, food and drink safety, climate change,

Macro-environment analysis is highly important: having a clear overall picture of company's surroundings will help it not only to take opportunities, but also to defend against threats better than its competitors (Strategic Management Analysis, 2014).

3.2.2 Micro-environment analysis

Micro-environment is the environment made up of factors that are very close to the organization, which may interact with the firm (Xu 2005). The five forces model, developed by Michael E. Porter, which is applicable in any industry, can be used to analyse the company's position in the industry and evaluate its competitiveness. The model helps companies to assess the nature and understand dynamics of an industry, and formulate sound strategies and compete effectively in the marketplace (Chartered Global Management Accountant 2014, Entrepreneurial insights 2014). The figure 1 demon- strates the framework and interrelation between the elements.

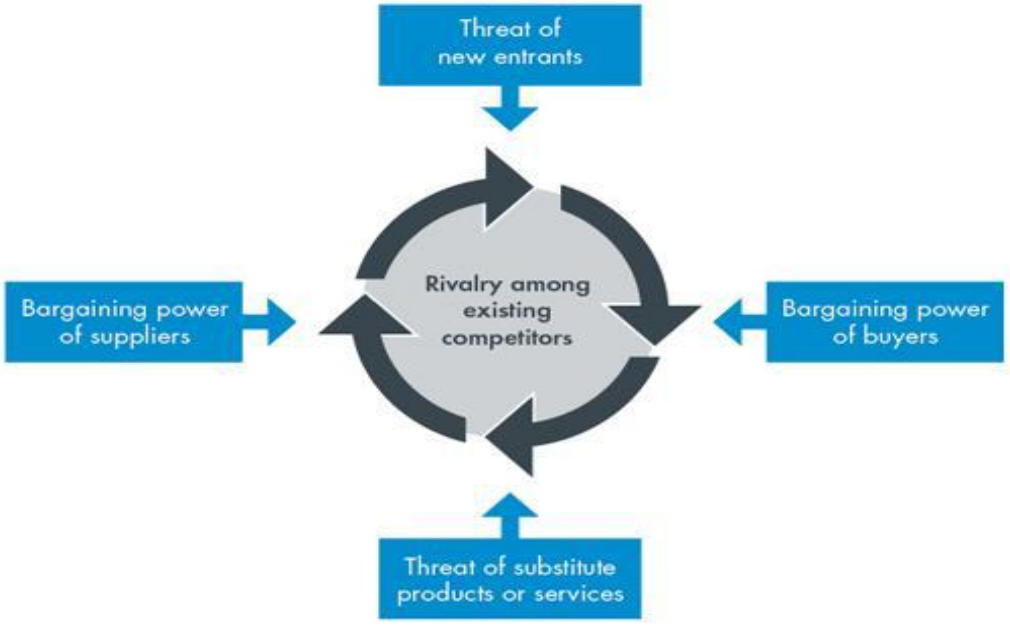


FIGURE 3.1. Porter's Five Forces model (adapted from Chartered Global Management Accountant 2014)

These five forces include competitive rivalry, threat of new entrants, threat of substitute products or services, bargaining power of buyers, and bargaining power of suppliers.

3.2.3 Internal environment

Ferrell and Hartline (2011) stated that if a company is already present in a market, its internal environment must be analysed before external market analyses. Internal environment, are those elements the firm has a strong influence. These elements are company objectives, strategies, decisions regarding marketing mix, management and employees, physical resources including infrastructure, vision and mission, research and development activities, working conditions, etc. (Jain et al., 2010). The task of a company is to organize these controllable elements in the way that they benefit the company, and do adjustments in respond to changes in the external environment (Cateora & Graham, 2007).

With the purpose to analyse the internal environment, first of all, the firm's current marketing objectives must be reviewed, they must be consistent with the company's mission and external environment. Second, the complexity of the strategic planning process, i.e. the process of identification and establishment of a company's corporate strategy, marketing goals and plans should be considered. The complexity or straight- forwardness of the process depends on a company's size and structure, for example strategic planning for large multinational corporations is very complex, whereas planning for a sole proprietorship is rather simple. (Pride

& Ferrell, 2014) Third, the current and anticipated organizational resources should be reviewed. These include the examination of financial and human resources, relations with supply chain members and other partners. (Ferrell & Hartline, 2011).

Swine producers typically market their pigs to several distributors, and a lack of uniformity in measuring and reporting carcass data exists among swine producers (Schonfeld, 2001). Because of this inconsistency, producers find it difficult, if not impossible, to compare their market hogs with pigs from other operations.

A large number of forces shape the marketing environment. To help organize the thought, it's useful to classify the various forces as falling into either the (1) direct market environment or (2) the external market environment. The direct environment of any generic market or product-market includes customers, the company, and competitors (Mwangulu, 2014). The external market environment is broader. The variables of the external market environment fall into four major areas:

1. Economic environment.
2. Technological environment.
3. Political and legal environment.
4. Cultural and social environment.

The marketing environment is so complex that the marketing manager does not have control over l the variables of the marketing environment. That's why it is sometimes useful to think of them as uncontrollable variables. On the other hand, the marketing manager can and should be able to carefully consider the environmental variables when making decisions that can be controlled. For example, a manager may not be able to do anything to offset the strengths of a specific competitor, but the manager can select strategies that lead the firm into product-markets where that firm does not compete, or where competition in general is not as strong.
In a macro-marketing sense, consumers in market-directed economies have granted businesses the right to operate and to make a profit if they can. With this right comes the responsibility for businesses to be dynamic agents of change, adjusting their offerings to meet new needs. Competition is supposed to encourage innovation and efficiency. A business firm should develop an organization that ensures these consumer-assigned tasks are carried out effectively and that the firm itself continues to prosper.

In the long run, a firm must make a profit to survive. But just saying that a firm should try to make a profit isn't enough. Management must specify the time period involved, since many plans that maximize profit in the long run lose money during the first few years. On the other hand, seeking only short-term profits may steer the firm from opportunities that would offer larger long-run profits. According to Kotler & Armstrong (2006) many companies (including powerful international companies) that are struggling financially, failed at the heartbeat of marketing, namely:

- Failing to understand the changing environment,
- Failing to understand their consumers and
- Failing to provide value – a basic inherent need of the consumer.

3.3 Game Theory for Swine Marketing Channels

Game theory has been traditionally used in military strategy (Siiman & Cruz, 1975; Bacharach, 1977). Kotler and Singh (1981) reported that competition in markets is somehow similar to competition in the battlefield. Since the first formalisation of game theory by Von Neuman and Morgastern (1944), researchers have been debating about the possibility to apply game theory to solve marketing problems, and in particular to use it as a tool to predict competitive behaviour (Herbig, 1991). Later on, the debate has been extended to all the other possible uses of game theory in marketing. Management decisions about marketing mix have to be taken in situation of competition and variability in the business environment. Porter (1980) clearly states the relevance to consider the possible effects of competitor's strategic decisions on every level of managerial decision process.

According to many authors the assumption on which game theory is based are too constrictive and is too theoretic to be widely employed in managerial practice (Wagner, 1975; Lazer & Thomas, 1974; Moorthy, 1985; Tullock, 1987). Furthermore, the axiomatic approach to define the player of the game clashes with the marketing research approach which is based on empirical observation, measurement and analysis of consumers' response. Although game theory has apparently a great potential for marketing (Re, 2000), its role is still controversial in the marketing literature and its use as a marketing tool is very rare.

3.3.1 Basic assumptions of Game Theory

The aim of game theory is to: "provide a formal language to describe conscious and goal-oriented decision processes that involve one or more players" (Shubik, 1972). In its original

formulation, game theory includes some of the assumption of neoclassic economic theory (Herbig, 1991):

I. Complete information: every player knows all the rules of the game and the preferences of the other players for each result.

II. Perfect information: every player is exhaustively informed about all the choices foregoing the time of his decision.

III. Rationality of decision process: every player takes decisions based on the maximization of his utility function; in case of uncertainty the player makes subjective predictions based on probability in order to calculate his utility function.

IV. Intelligence: every player is rational and able to predict the choices of other players, thinking about what would be the rational choice he would take if he was in the same situation of another player.

V. Competitive and non-cooperative behaviour: as a consequence of the previous assumptions, individual choices are based on the maximization of each individual utility function and not on that of all the players as a whole. There is a non-cooperative bias which, from a systemic point of view, brings to non-optimal choices, like in the prisoner's dilemma.

VI. Dynamism: player's situations, as well as environmental factors, are changeable; therefore, most games are non-static and do not supply a single move solution.

VII. Interdependence: the results of each player are mutually related with decisions of other players; thus, unilateral decisions are not possible.

VIII. Time: the result is affected by the length of the game.

IX. interactivity: game theory attempts to establish equilibrium between different players.

Advantages of using Game Theory for Marketing Decisions

Despite the strong criticisms, we can find also several authors supporting the value of game theory for marketing, giving partial answers to some of the criticisms. According to Di Benedetto (1986), it is possible to demonstrate, with few logical revisions, the relation between the economic definition of game and marketing decision process. According to Bacharach (1977), game theory has the following attributes:

a) A well-defined set of possible ways of action for each player;

b) Each player has well defined preferences within the possible results of the game;

c) Relations and results are determined by the choices of the ways of action made by the players;

d) Every player has complete knowledge of the attributes above.

These “mixed strategies” can be considered as interesting attempts to overcome the limits of complete information of the classical game theory, thus making it more suitable to be used in marketing decisions concerning competitive strategy.

3.3.2 Game Theory and Distribution

We can find several studies utilizing non-cooperative game theory to analyze the relations among producers and dealers along distribution channels. The approach used is usually the “leader-follower” (Weitz & Wang, 2004). Other studies approach the problem of competition along distribution channel and demonstrate that the double marginalization is reduced by the increase of competition at retailer level (McGuire & Staelin, 1983; Chouglan, 1985). Chouglan (1985) approaches the problem of channel choice in a duopolistic market and shows how the integration of distribution function along the distribution channel creates higher price competition and lower prices compared to the utilization of dealers.

With reference to the aforementioned results, Choi (1991) analyzed a distribution channel structure with two producers and one retailer selling both products. Choi approached the problem using three kinds of non-cooperative games (two with Stackelberg duopoly and one with Nash’s equilibrium) and shows how the results depend by the shape of demand function: There are several possible applications of game theory for marketing management decisions, but they are all limited to specific cases. Game theory can be of some utility in marketing decisions when the number of players is little. This is a big limitation which excludes it from effective application to business to consumer markets.

3.4 Market Segmentation

The term “market segmentation” refers to subdividing a market along some commonality, similarity, or kinship. In other words, the members of a market segment share something in common. The purpose of segmentation is the concentration of marketing energy and force on the subdivision (or the market segment) to gain a competitive advantage within the segment (Jerry, 2017). Market segmentation strategy involves dividing the market into groups, where individuals have similar needs and wants for services and products. It could also be a segmentation of people on the basis of behaviour, culture, and economic status. All markets are heterogeneous. This is evident from observation and from the proliferation of popular books describing the heterogeneity of local and global markets. Consider, for example, *The Nine*

Nations of North America (Garreau, 1982), *Latitudes and Attitudes: An Atlas of American Tastes, Trends, Politics and Passions* (Weiss, 1994) and *Mastering Global Markets: Strategies for Today's Trade Globalist* (Czinkota *et al*., 2003).

When reflecting on the nature of markets, consumer behaviour and competitive activities, it is obvious that no product or service appeals to all consumers and even those who purchase the same product may do so for diverse reasons. Effective marketing and business strategy therefore require a segmentation of the market into homogeneous segments, an understanding of the needs and wants of these segments, the design of products and services that meet those needs and development of marketing strategies, to effectively reach the target segments. Thus focusing on segments is at the core of organizations' efforts to become customer driven; it is also the key to effective resource allocation and deployment. The level of segment aggregation is an increasingly important issue. In today's global economy, the ability to customize products and services often calls for the most micro of segments: the segment of one. Following and implementing a market segmentation strategy allows the firm to increase its profitability, as suggested by the classic price discrimination model (Armstrong, 1999) which provides the theoretical rationale for segmentation.

Since the early 1960s, segmentation has been viewed as a key marketing concept and has been the focus of a significant part of the marketing research literature. The basic concept of segmentation (as articulated, in Frank *et al.*, 1972) has not been greatly altered. And many of the fundamental approaches to segmentation research are still valid today, albeit implemented with greater volumes of data and some increased sophistication in the modeling method. To see this, consider the most compelling and widely used approach to product design and market segmentation – conjoint analysis. The essence of the approach outlined in Wind (1978) is still evident in recent work by Toubia *et al*. (2007), that uses sophisticated geometric arguments and algorithms to improve the efficiency of the method. Other advances use formal economic theory to specify optimal consumer trade-offs (Lyengar*et al*., 2007).

Despite the underlying stability of the basic concept, recent advances in information technology and the trend towards globalization are introducing a discontinuous change to the adoption and implementation of segmentation strategies. The revolution in information technology and strategy makes possible the creation of databases on the entire universe and enormous advances in database marketing and innovative distribution approaches. It has also facilitated much of the development in flexible manufacturing with the consequent emergence of mass

customization. In addition, the Internet has expanded not only the ability to implement market segmentation research more effectively, but also expanded the portfolio of segmentation methods available for use (Dahan & Srinivasan, 2000). These changes are leading to the creation of one-on-one marketing' or segments of one. The globalization of business expands the scope of operations and requires a new approach to local, regional and global segments. Moreover, businesses that have not traditionally embraced marketing in general or segmentation in particular, see it as imperative for success and even survival.

2.4.1 Theoretical and empirical evidences of market segmentation:

There are many factors which can be responsible for market segmentation traditional as well as modern or new. Amandeep and Singh (2011) reveals in his study that earlier demographic factors were considered as best basis of segmentation but they are no longer effective for segmentation in FMCG sector. An investigation of 500 consumer's purchase routine and their demographic attribute are found non-associated in this study.

This study shows that purchasing of FMCG products especially personal care products is indifferent of age, educational level. But there is an effect of gender and educated and non-educated consumers on the purchase routine of personal care products. It means there is a need for developing more effecting marketing segmentation basis. This study is related to only one industry may not be applicable to others. But it is rightly proved that demographic which are considered as most effective attribute that influence the purchase of consumer not powerful enough in today life.

Victoria, Shing and Jorge (2010) in their study present an idea that benefit sought are more powerful basis of brand choice. They also reveal the idea that demographic attributes are not very effective in case of brand choice and in price selection. The demographic variables of interest were age, gender, household size, occupation, education and level of income. Results of this study shows the demographic influence on choice of retail outlet is partial with household size, education and income having a significant effect on the choice of retail outlet selected. This study shows that some of the demographical factors like education, income and household size effect the choice of retail outlet and definitely the choice of brands also (Salma, 2010).

On the other hand, Kamineni (2009) presented the idea that demographic is now failed to effective segmentation and only psychographic is not sufficient to segment today's complex

market in which consumers have a different type of ideology. This study gives an idea about new basis of segmentation that can be applicable with the help of Enneagram that is an ancient technique of personality indicator. This technique has a combination of psyche and spirituality of personality. This study gave a different idea about segmentation which is not in practice but can be proved very useful**.**

Wedel (2002), in his editorial article states that market segmentation has now become a necessity of marketers. One to one marketing is no feasible because it need great amount of money and efforts that directly affect the profit of the company. This article put stress on an understanding of the dynamic nature of preferences and market segment composition is essential for strategies focused on the evolution rather than the proliferation of products and businesses.

Singh (2010) highlighted the need of using a new theoretical foundation of market segmentation which will help the FMCG companies to segment the market in competition-oriented marketing to gain fruitful results. This research paper proposes 5 golden rule of market segmentation which are as:

1. There are “No Rules”: Getting it right isn’t simple at all. But never copy. Each successful segmentation process is different, unique, and unrepeatable. The "me too" attitude leads to failure. Originality could possibly break a market open.
2. “Reducing” a market? Sometimes it’s about expanding it. Some of the most successful marketing plans have chosen a larger market by “expanding” their segmentation, not only reducing it.
3. The “Value” of the segment: The best segments must have Potential, Lifespan, Accessibility, and Profitability. The key is identifying which segments provide value in terms of potential, lifespan, accessibility and profitability; because a sales strategy’s effectiveness increases according to our capacity to size segments, identify them, and dissect them.
4. It must be “Different”: Each company requires a different Market Segmentation. Being original and efficient with segmentation is the key to the amount of success achieved. We create new and personalized ways of segmenting, creating Hybrid models that are easy to interpret and explain (causes, value, behavioral, psychographic, demographic, and attitudinal) in order to obtain the most useful results from each sectorial situation and each company.
5. Choosing “The Axes” properly: Time segmentation and spending causes, demographic but with attitudinal axes, and Psychographic but with a behavioral

aspect? Surely there is an answer, but to find it we must investigate, test, and challenge the market. Higgs, Bronwyn and Ringer, Allison (2007) in their study discusses about the different segmentation basis and shows that a number of specialized segmentation approaches are emerged in the changing environment. The author suggests some of the following specialized method of market segmentation:

- Finer and Hyper-segmentation
- Progressive Profiling
- Addressable marketing method

Finer segmentation defined as a more precise way to segment markets into narrow clusters. Progressive profiling involves incremental data collection across sessions and interaction points typically online. Addressable marketing exploits the potential of digital communications devices to gather information about online behaviors including site visitation, site engagement, and content involvement and advertising exposure.

However different basis of market segmentation has their importance in different market but in today's competing market only traditional basis as demographic, geographic, psychographic and behavioral are not enough. Other factors as benefit sought, ethnocentric approach etc. are also playing their role to segment the consumer market.

Russell I. Haley (1968) proves that most techniques of market segmentation rely only on descriptive factors pertaining to purchasers and are not efficient predictors of future buyer behavior. The author proposes an approach whereby market segments are delineated first on the basis of factors with a causal relationship to future purchase behavior. The belief underlying this segmentation strategy is that the benefits which people are seeking in consuming a given product are the basic reasons for the existence of true market segments.

3.4.2 Strategies for Market Segmentation

How a market is segmented is based on certain variables. According to Kotler and Armstrong (2006) variables used for segmentation include behavioural, demographic, psychographic, and geographic differences.

- Psychographic Segmentation

  Segmenting people according to their lifestyle and values, and how they translate into consumption or purchases of products or services is what psychographic segmentation

is all about. How one's interest, opinions, values, attitude, and the activities they perform, affect their choices and why a group of people would lean towards one product more than others. A high status would translate into an expensive flying habit, while a thrift value will translate into an economy flight.

- Geographical Segmentation

  Geographical segmentation is done by dividing people (markets) into different geographical locations. The country, state, or neighbourhood, the king of gentry, climate, size of a place segmented into size of its age wise population, etc., all play a role in devising market strategies. This helps the producer and the marketers to understand what will sell and what won't. For example, a market for winter wear would definitely not work in warm regions.

- Demographic Segmentation

  Demographic segmentation refers to a wide study of potential customers. While marketing a product, many variables like age, gender, education, income, family size, occupation, socioeconomic status, culture, religion, language, and nationality are taken into account. There are many instances where such segmentation has worked very profitably. This segmentation plays a vital role in determining whether a product can be mass marketed or designed for a specific clientele.

- Behavioural Segmentation

  Behavioural segmentation is based on the customer's needs and subsequent reaction to those needs or towards the purchase of intended products and/or services. This study is conducted on all variables that are closely related to the product itself, like loyalty to a particular brand, cost-effectiveness in terms of benefits and usage, circumstances responsible for the purchase, whether the customer is a regular, a first timer, or and has the potential to become a customer, and whether the readiness to buy is linked to status. Before a company launches its services, it not only studies a market segmentation strategy, but relates it in terms of a product life cycle theory. Both the concepts combined, give the marketer a clear idea of what would be profitable.

- Target Market Selection Segmentation and Positioning

  From a high-level, the goal of a marketing strategy is to identify a target market and develop a marketing mix that will appeal to those potential customers. Decisions regarding the ideal marketing mix can be organized in terms of Price, Promotion, Product, and Price. However, the goal is not to just come up with a particular strategy, but rather to focus on providing value to your key market segments.

There are four basic types of market opportunities: Market Penetration, Market Development, Product Development, and Diversification.

Adapted from Analyst perspectives blog, demand metrics: Target market selection segmentation and positioning August 6, 2008. Blog.demandmetric.com, accessed on 11/22/2013

1. **Market Penetration** is the attempt to increase sales of current products in present markets. Some strategies to penetrate markets include: more aggressive marketing, increasing service to improve renewal rates, or attracting competitor customers directly.

2. **Market Development** is the effort to increase sales by selling current products into new markets. Firms may advertise to reach new target customers within a geographic region, or look to international markets for expansion.

3. **Product Development** refers to offering new or improved products to present markets. By working closely with your customers, you may find new and innovative ways to better satisfy your target market.

4. **Diversification** means opening completely new lines of business, with new products in new markets. Many organizations diversify their product mix to mitigate risks related to economic variables such as recessions.

   Most companies look to markets that are close to home, since they are more familiar and can be responded to quickly. Additionally, it is more profitable to retain, rather than recruit new customers. For these reasons, market penetration is usually the first type of opportunity a firm will evaluate. Conversely, many organizations have found that market development, especially in rapidly growing economy, is the key to their success.

3.4.2.1 Market Segmentation Best Practices

Market segmentation is a two-step process of: naming broad product markets, and segmenting those markets in order to select target markets. Most segmentation efforts fail because inexperienced marketers attempt to find one or two demographic characteristics to segment a mass market. Generally, customer needs and behaviours do not incorporate nicely into one or two demographic characteristics.

1. Defining Generic and Product Markets

A market is a group of potential customers who have similar needs and are willing to purchase goods or services to satisfy those needs (Kotler & Armstrong, 2006). Good marketers focus on the customer and develop marketing mixes for very specific target markets. On the other hand, poor marketers focus on their products when defining markets, leading to missed opportunities and questionable customer satisfaction. The point here is that a market is external to an organization; it doesn't make sense to segment potential markets based on the features contained in your products or services.

When narrowing down the mass market, it is helpful to think of two basic types of markets: generic markets and product markets. A generic market is a market of customers with generally similar needs, which organizations satisfy in a variety of ways. An example of a generic market would be the transportation market for a city; buses, trains, cars, bicycles, and walking, are all methods of getting around town (Kotler & Armstrong, 2006).

Contrastingly, a product market is a market of customers with very similar needs. An example of a product market would be for swine species, where customers have the choice between products from Large White, Duroc, Berkshire, and Landrace etc.

There are four important aspects to consider when defining product market:

1. **What** - Product Type
2. **To Meet –** Customer Needs
3. **Who** - Customer Segments
4. **Where** - Geographic Region

Once a product market is defined, you are ready to continue the segmentation process to identify potential target markets.

2. Understand Common Market Segment Dimensions

There are common market segment dimensions for consumer and B2B markets. Following are two lists containing sample dimensions that can be used to slice and dice your consumer or B2B product markets. Be very careful when selecting your dimensions, as these parameters will form the basis for defining your target markets.

3. Group Customers into Homogeneous Micro Segments

In this stage of the segmentation process, your goal is the find customers who have similar needs that will respond to a marketing mix in a predictable manner.

Following are 4 criteria that strong market segments have in common:

1. **Homogeneous** - customers in a market segment should be very similar in both their segment dimensions and their likely response to a marketing mix.
2. **Heterogeneous** - customers in different market segments should be as divergent as possible with other segments.
3. **Economic Upside** - the segment needs to be large enough, or predicted to grow sufficiently, to be profitable.
4. **Operational** - the segment dimensions should be helpful for understanding &identifying customers and making decisions regarding the marketing mix.

Market segment should be operational. The main point of segmenting is to assist with better targeting, positioning, and decision-making. When distinct market segments based on various dimensions, have been established, then targeting your potential customers can take off.

3.5 Marketing Communication

The growing expectations for quality and safety of food products and an increasing demand for more transparent food supply chains have caused new challenges for pork production. In the course of this development, chain-wide communication has gained importance in agribusiness. Nonetheless, existing approaches focus primarily on information supply, whereas the use of information for managerial decision-making has only rarely been highlighted. (Ludwig, Cord-Herwig & Ludwig, 2012*)*.

Since the mid-1990s, a political reaction has resulted in the legislation and administration of new food production legislation which encompasses the entire supply chain “from the farm to the fork”, from the pre-production areas of agriculture on through the production, manufacture, and distribution of the products (Fritz & Fischer 2007; Härtel, 2007). Industry in turn has responded by implementing various quality control systems, the central element of

which similarly aims to oversee all or at least the most important stages in the food production process (Hatanaka, Bain & Busch 2005; Jahn, 2006; Peupert &Theuvsen, 2007).

The continuous exchange of communication among all supply chain partners has become extremely important due to the efforts made by legislators and agribusiness firms to assure the improved quality of food products. Therefore, various efforts have been made to improve communication between supply chain partners. Examples of this development are new legislation concerning the exchange of information on salmonella monitoring in pork production, Regulation (EC) 853/2004 as part of the so-called "hygiene legislation package" regarding food supply chain in-formation, and the requirements established by certification systems to pass on information to supply chain partners (Ziggers & Trienekens, 1999; Schulze Althoff, Ellebrecht & Petersen, 2005; Deimel, Plumeyer & Theuvsen, 2008a). So far the exchange of information in agribusiness, particularly in the meat industry, has been hindered by considerable organizational and structural barriers. The transfer of information is difficult due to complex supply chain structures, resulting in numerous organizational interfaces along supply chains, each of which acts as a hurdle the information flow has to overcome (Deimel, Frentrup & Theuvsen, 2008). In the meat supply chain, the interface between agribusiness firms like abattoirs and farmers seems to be the most difficult relationship due to structural and organizational disparities (Deimel, Plumeyer & Theuvsen 2009). Moreover, the local farmers find it extremely difficult to assess the abattoirs due to the cost of transportation. Therefore, in recent years great efforts have been made to take advantage of modern information technologies that allow a multitude of information on food quality derived from the findings at abattoirs to be systematically gathered and made more available to farmers in order to enable them to improve their animal health (AH) management (Plumeyer, Theuvsen & Bahlmann, 2009).

Research conducted in various industry subsectors and regions has indicated that communication plays a decisive role in firm performance (Narver & Slater ,1990; Deshpande, Farley, & Web-Ster, 1993; Bigne & Blesa, 2003). Fawcett and Magnan (2001) posited that "information is the *'life blood'* of effective supply chain management". In a survey of firm managers, Baker and Sinkula (1999) observed that not only firm performance but also innovativeness correlates significantly with the exchange of information. Moreover, the exchange of information among partners is an essential determinant of the successful strategic positioning of firm net-works (Jarillo, 1988). Other network theories also consider the

continuous exchange of information an essential success factor (Miles & Snow, 1984; Granovetter, 1985).

Empirical studies have repeatedly confirmed the importance of a continuous exchange of information in food supply chains (Hill & Scudder 2002; Reiner, 2005; Schulze, Spiller & Theuvsen, 2006b). Caswell and Mojduszka (1996) and Theuvsen, Plumeyer and Gawron (2007) emphasized the high relevance of information exchange for food quality and safety. Lazzarini, Chaddad and Cook (2001) as well as Windhorst (2004) saw the unhindered flow of information between supply chains partners as an essential precondition for the integration of supply chains and networks in the agribusiness sector. Whereas Hollmann-Hespos (2008) analysed determinants of investments in tracking and tracing systems that aim at the improvement of information flows relevant for traceability of food and feed products, Peupert and Theuvsen (2007) discuss how the exchange of quality information in agribusiness can be supported by the use of quality techniques such as quality function deployment.

In addition to the availability and supply of information, its use is also a key success factor (Moorman, Zaltman & Deshpande, 1992). The use of information constitutes a cognitive process that encompasses the acquisition, processing and storage of information, as well as the effect (e.g., the actions of the information user) (O'Reilly, 1982). Choo (1996), Weißenberger (1997) and Thong (1999) consider the use of information as the primary goal of the information exchange.

Marketing communications is a subset of the overall subject area known as marketing. Marketing has a marketing mix that is made of price, place, promotion, product (known as the four P's), that includes people, processes and physical evidence, when marketing services (known as the seven P's). Marketing communication (MarCom) is a fundamental and complex part of a company’s marketing efforts. Loosely defined, MarCom can be described as all the messages and media you deploy to communicate with the market. This includes advertising, direct marketing, branding, packaging, your online presence, printed materials, PR activities, sales presentations, sponsorships, trade show appearances and more.

How does marketing communications fit in? Marketing communications is 'promotion' from the marketing mix. Communication generally requires one being able to pass information in a clear and understandable manner so that the receiver will not find it difficult to decode. In other for a product (swine) to be communicated to the consumers, a good product promotion channel is

required. There is a need to choose a media that suits the customers. (eg. Newspapers, websites, marketing networks etc) If someone does not know how to do the promo, an expert should be hired to assist. There is a saying that if someone does not tell people that s/he is here, they will not see that one. So, if people don't know about someone, they have nothing to tell their friends about that one.

The modern technology has made the world a global village. One can reach customers through different channels. Outstanding means of communication presently is the use of social networks. Social marketing is seen as the new word of mouth. The use of smart phones, Facebook, twitter, black berry etc can make communication easy to select groups with common interest, personalize messages to different segment.

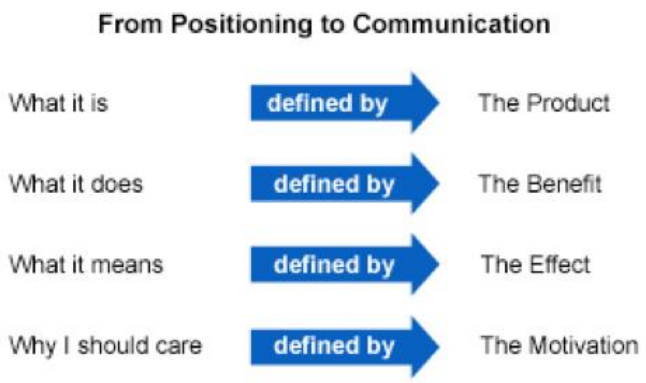
Marketing communication is encompassing or integrated. Integrated means combine or amalgamate, or put simply the jigsaw pieces that together make a complete picture. This is so that a single message is conveyed by all marketing communications. Different messages confuse your customers and damage brands. So, if a TV advert carries a particular logo, images and message, then all newspaper adverts and point-of-sale materials should carry the same logo, images or message, or one that fits the same theme.

3.5.1 Marketing communication objectives

Marketing communication has two objectives. One is to create and sustain demand and preference for the product. The other is to shorten the sales cycle.

Creating preference

Creating preference is often a longer-term effort that aims at using communication tools to help position your product or company in the minds of the target customer. Positioning and building a brand take time and requires a certain consistency (not just in the communication efforts themselves, but also in regards to the core elements of product, pricing, and distribution) and therefore represents a significant commitment for the company. However, establishing preference by building a brand will impact market share, profitability and even your access to talent—and thus provides long-term value for the company."



Adapted from Analyst perspectives blog, demand metrics: Target market selection segmentation and positioning, August 6, 2008. Blog.demandmetric.com, accessed on 11/22/2013

Shortening the sales cycle

Shortening the sales cycle means assisting your sales and channel partners in their efforts to identify, engage and deliver a customer. Understanding the customer's buying process brings critical insight into how one can shorten the sales cycle. The figure below illustrates the process the buyer goes through when buying a product.

Fig. 3.3 Shortening the sales cycle

Adapted from Analyst perspectives blog, demand metrics: Target market selection segmentation and positioning, August 6, 2008. Blog.demandmetric.com, accessed on 11/22/2013

In general, the communication techniques employed to shorten the sales cycle are by nature more tactical than those used in building a brand. You must have close collaboration with sales and customer-facing channel partners in order to get this balance right.

Integrated Marketing Communications is a simple concept. It ensures that all forms of communications and messages are carefully linked together. At its most basic level, Integrated Marketing Communications, or IMC, as we'll call it, means integrating all the promotional tools, so that they work together in harmony.

3.5.2 Benefits of IMC

Although Integrated Marketing Communications requires a lot of effort it delivers many benefits. It can create competitive advantage, boost sales and profits, while saving money, time and stress.

IMC wraps communications around customers and helps them move through the various stages of the buying process. The organisation simultaneously consolidates its image, develops a dialogue and nurtures its relationship with customers.

This 'Relationship Marketing' cements a bond of loyalty with customers which can protect them from the inevitable onslaught of competition. The ability to keep a customer for life is a powerful competitive advantage.

IMC also increases profits through increased effectiveness. At its most basic level, a unified message has more impact than a disjointed myriad of messages. In a busy world, a consistent, consolidated and crystal-clear message has a better chance of cutting through the 'noise' of over five hundred commercial messages which bombard customers each and every day.
At another level, initial research suggests that images shared in advertising and direct mail boost both advertising awareness and mail shot responses. So IMC can boost sales by stretching messages across several communications tools to create more avenues for customers to become aware, aroused, and ultimately, to make a purchase

IMC also makes messages more consistent and therefore more credible. This reduces risk in the mind of the buyer which, in turn, shortens the search process and helps to dictate the outcome of brand comparisons.

Un-integrated communications send disjointed messages which dilute the impact of the message. This may also confuse, frustrate and arouse anxiety in customers. On the other hand, integrated communications present a reassuring sense of order.
Consistent images and relevant, useful, messages help nurture long term relationships with customers. Here, customer databases can identify precisely which customers need what information when... and throughout their whole buying life.

Finally, IMC saves money as it eliminates duplication in areas such as graphics and photography since they can be shared and used in say, advertising, exhibitions and sales literature. Agency

fees are reduced by using a single agency for all communications and even if there are several agencies, time is saved when meetings bring all the agencies together - for briefings, creative sessions, tactical or strategic planning. This reduces workload and subsequent stress levels - one of the many benefits of IMC.

3.5.3 Limitations to IMC

Despite its many benefits, Integrated Marketing Communications, or IMC, has many limitations. In addition to the usual resistance to change and the special problems of communicating with a wide variety of target audiences, there are many other obstacles which restrict IMC. These include: Functional Silos; Stifled Creativity; Time Scale Conflicts and a lack of Management know-how.

Take functional silos. Rigid organisational structures are infested with managers who protect both their budgets and their power base. Sadly, some organisational structures isolate communications, data, and even managers from each other. For example the PR department often doesn't report to marketing. The sales force rarely meets the advertising or sales promotion people and so on. Imagine what can happen when sales reps are not told about a new promotional offer.

All of this can be aggravated by turf wars or internal power battles where specific managers resist having some of their decisions (and budgets) determined or even influenced by someone from another department.

3.5.4 Communications Theory

Simple communications models show a sender sending a message to a receiver who receives and understands it. Real life is less simple - many messages are misunderstood, fail to arrive or, are simply ignored.

Thorough understanding of the audience's needs, emotions, interests and activities is essential to ensure the accuracy and relevance of any message. Instead of loud 'buy now' advertisements, many messages are often designed or 'encoded' so that the hard sell becomes a more subtle soft sell. The sender creates or encodes the message in a form that can be easily understood or decoded by the receiver.

Clever encoding also helps a message to cut through the clutter of other advertisements and distractions, what is called 'noise'. If successful, the audience will spot the message and then decode or interpret it correctly. The marketer then looks for 'feedback' such as coupons returned from mailshots, to see if the audience has decoded the message correctly.

The single step model - with a receiver getting a message directly from a sender - is not a complete explanation. Many messages are received indirectly through a friend or through an opinion leader.

Communications are in fact multifaceted, multi-step and multi-directional. Opinion leaders talk to each other. Customers talk to opinion leaders and they talk to each other.

Understanding multiphase communications helps marketers communicate directly through mass media and indirectly through targeting opinion leaders, opinion formers, style leaders, innovators, and other influential people.

How messages are selected and processed within the minds of the target market is a vast and complex question. Although it is over seventy years old, rather simplistic and too hierarchical, a message model, like AIDA, attempts to map the mental processes through which a buyer passes en route to making a purchase.

There are many other models that attempt to identify each stage. In reality the process is not always a linear sequence. Buyers often look backwards at various stages perhaps for more information. There are other much more complex models that attempt to map the inner workings of the mind.

In reality, marketers have to select communications tools that are most suitable for the stage which the target audience has reached. For example, advertising may be very good at raising awareness or developing interest, while free samples and sales promotions may be the way to generate trial.

3.6 Relationship Marketing

Relationship marketing refers to everything you do to make your prospective and current customers aware of your products and services, position your business in their minds as the obvious choice, and help you to build lifelong, profitable relationships with them Kotler, P.,

Armstrong, G., Cunningham, P.H. 2005). Relationship marketing (RM) marks a significant paradigm shift in marketing, a movement from thinking solely in terms of competition and conflict toward thinking in terms of mutual interdependence and cooperation. It recognizes the importance of various parties—suppliers, employees, distributors, dealers, retailers—cooperating to deliver the best value to the target customers.

One of the most effective ways to market your services and brand is through the strong relationships you already have with existing clients. Relationship marketing leads to a greater client experience with your firm. A greater client experience translates into a stellar reputation for your firm, which in turn leads more of the right clients to your door.

Whereas the traditional marketing approach is transactional, relationship marketing is relational. Old-style marketing mostly focuses on sales transactions. The new relationship marketing focuses on working hand-in-hand with your prospects and customers to co-create a more meaningful, personalized, and lasting experience.

With the vast range of social media tools at our disposal today, it's easier now more than ever to shift your focus from transactional marketing to relational marketing. Your customers and prospects want to know that you're listening, that they are important to you, and that you are striving to improve your brand, products and services as a result of their feedback. You can't afford to be a one-way broadcast channel. You need to embrace the conversation and, never stop to communicate. The more you relate to your customers, the more you get to know their needs and ways to satisfy them.

One of the things of most value to a company is its relationships with customers, employees, suppliers, distributors, dealers, and retailers. The company's relationship capital is the sum of the knowledge, experience, and trust a company has with its customers, employees, suppliers, and distribution partners. These relationships are often worth more than the physical assets of a company. Relationships determine the future value of the firm. Any slips in these relationships will hurt the company's performance. Companies need to keep a relationship score-card that describes the strengths, weaknesses, opportunities, and threats in regard to the relationship. Your company needs to move fast and repair any important but weakening relationships.

Traditional transaction marketing (TM) tended to ignore relationships and relationship building. The company was viewed as an independent agency always manoeuvring to secure the best

terms. The company was ready to switch from one supplier or distributor to another if there was an immediate advantage. The company assumed that it would normally keep its current customers, and it spent most of its energy to acquire new customers. The company neglected the interdependence among its main stakeholders and their roles in affecting the company's success.

The main characteristics of relationship marketing include:

- It focuses on partners and customers rather than on the company's products.
- It puts more emphasis on customer retention and growth than on customer acquisition.
- It relies on cross-functional teams rather than on departmental-level work.
- It relies more on listening and learning than on talking.

The shift toward relationship marketing does not mean that companies abandon transaction marketing altogether. Most companies need to operate with a mixture of the transactional and the relational marketing approaches. Companies selling in large consumer markets practice a greater percentage of TM while companies with a smaller number of customers like most of the swine producers practice a higher percentage of RM.

The four Ps of the marketing mix can be reinterpreted as the four Cs. They put the customer's interests (the buyer) ahead of the marketer's interests (the seller).

Customer solutions, not products: Customers want to buy value or a solution to their problems. Customer cost, not price: Customers want to know the total cost of acquiring, using, and disposing of a product.

Convenience, not place: Customers want products and services to be as convenient to purchase as possible.

Communication, not promotion: Customers want two-way communication with the companies that make the product.

Source: Kotler, P., Armstrong, G., Cunningham, P.H. (2005). *Principles of Marketing.* Toronto: Pearson Education Canada.

3.7 Direct Marketing

Direct marketing involves selling products directly to consumers, thus allowing the producer the chance to receive a better price. Direct marketing allows producers to bypass traditional marketing channels and sell directly to consumers. This involves making a direct connection with consumers, determining their wants or needs, and producing the products that meet these Needs. Direct marketing of swine refers to the sale of swine products directly from ranches/feedlots to consumers. Direct marketing includes sales to grocery stores, restaurants, door-to-door, at farmers' markets, and through Internet delivery.

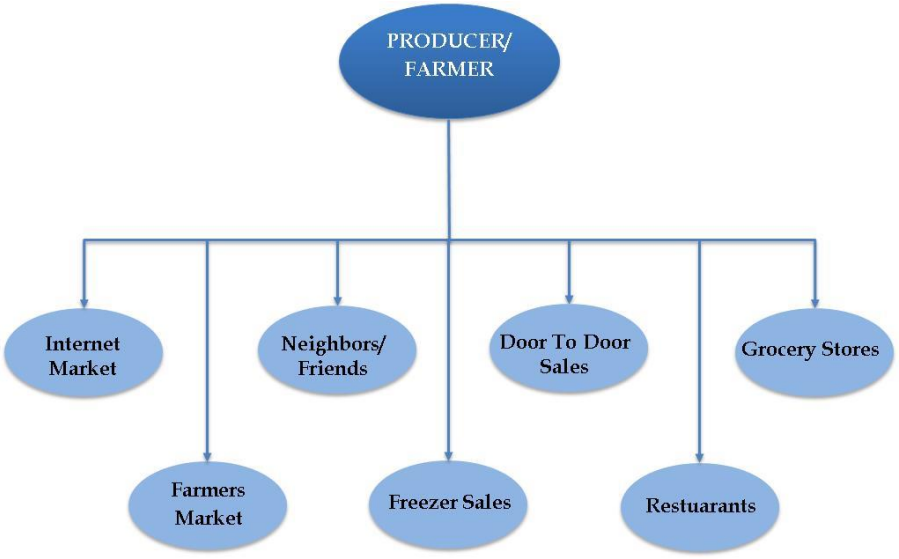


Fig. 3.7 Diagrammatical Representation of Direct marketing of Swine (Researcher's Concept, 2015)

Direct marketing of livestock products is not as common as direct marketing of fruits and vegetables because livestock products require a high degree of processing and are highly perishable. However, direct marketing can provide price premiums for producers. Direct marketing represents a niche marketing strategy for beef producers. The niche involves consumers who are highly concerned about food safety, environmental impacts of food production, animal welfare, production practices and who support local agriculture.

Numerous firms offer swine products through Internet sales. The majority of these sales involve frozen rather than fresh swine. One advantage of frozen swine sales is that it allows for longer shelf life and mitigates some seasonality problems.

Livestock marketing involves two components: (1) activities associated with the physical movement and transportation of livestock, and (2) pricing or placing a value on livestock. Direct marketing buyers acquire livestock directly from a farm rather than going through an intermediate market or party. Direct marketing serves well for farmers who are not in a hurry to sell their animals and who desire maximum price.

In most situations, direct marketing brings more money to the livestock farmer. No intermediary is involved to receive payment for services. Direct marketing may require more forethought and effort on the part of the seller, but the revenue goes directly to the producer. The seller must effectively and efficiently market the product in order to receive a premium price. This may require establishing contacts, advertising, accommodating visits from potential buyers, negotiating prices, making processing accommodations, and delivery arrangements. All these factors will influence direct marketing options. Even when a sale takes place directly from the farmer to the buyer, processing and transportation may become stipulations of the sale. For these efforts, the seller should receive a reasonable return after the transaction is complete. The producer is able to set the price of the sheep or goat and can sell it at a mutually agreed upon price or decline the opportunity if the price offered by a potential buyer is not satisfactory. The seller sets his or her own price expectations.

Direct marketing requires extensive considerations and involvement on the part of the producer. He or she needs to develop a marketing plan and strategy. The farmer becomes more than a producer; he or she becomes a marketing specialist. The farmer must develop an understanding of potential buyers, their preferences, their needs, and how to effectively target potential clientele. Research is necessary to understand potential clientele's ethnic backgrounds and preferences such as the age, sex, and type of animal they prefer. The producer must identify how to reach the target clientele and what promotional efforts will have significant results yet remain cost effective. Effective media outlets for reaching potential buyers include classified advertisements, flyers, radio advertisements, and the Internet. All effective advertising requires knowing consumer preferences, developing strategies, and being willing to evaluate and modify actions as needed.

The seller must consider processing and logistics when planning for direct marketing. Another consideration for the seller is whether the animal will be processed on site or hauled to a processor, or if the buyer will be responsible for making necessary arrangements. If the animal is processed on site, determine who will dispose of the offal. Is there an extra charge for

processing on site? The farmer must decide if he or she wants to deal with processing and must understand what obligations are implied. The best option may be for the seller to specify up front that processing is not allowed on site and that the buyer is responsible for further processing arrangements. The seller must also consider if the animal is to be transported and if a transportation fee is involved. In direct marketing, no sales commissions or fees are involved so all monies from the transaction go directly to the farmer. For this reason, direct marketing tends to be more beneficial to the producer. Direct marketing is not as simple as it may appear. Involvement and commitment by the farmer are required. However, the proceeds from the sale go directly to the seller.

3.7.1 Internet or Mail Order Marketing

There are advantages and disadvantages to Internet marketing. More consumers are shopping on the Internet, so Web sites can help buyers locate producers in their area, and Web sites are accessible 24 hours a day. A big disadvantage is that packaging and shipping costs can about double the final price of products for the consumers. Many people may browse the Web sites without making any purchases.

Internet marketing of pork requires a well-designed, user-friendly Web site that provides information about the producer's products and services. A more complex Web site may include a secure system to take orders and payments, and a method to address customer questions and problems. A simple Web site may contain only a phone number and contact address.

3.7.2 Farmers' Markets

In an article in Growing for Market, Aaron Silverman, a pastured-poultry and -lamb producer, discusses direct marketing of meat at farmers' markets. He says that meat marketing at farmers' markets has been slow to develop and that the burden of regulations for processing meat is part of the problem. Regulations vary by state—even between in-state localities—but most are consistent in one area: all meat sold has to be processed in a licensed facility. Silverman makes several suggestions for marketing meat in farmers' markets.

Marketing meat at farmers' markets is similar to marketing any value-added product, and very different than marketing vegetables or cut flower. Purchasing meat requires a heightened level of trust by the customer, since neither fondling nor smelling is possible. Your ability to gain, and more important, retain your customers' trust will determine your success marketing meats at farmers' markets.

We use three elements to gain our customers' trust. The first is the creation of a marketing brand—the customer's way of identifying our product outside of the farmers' market. Brand identity is even more critical when processing and marketing is done on a collaborative basis. Your brand is more than just your name, it encompasses the "who" and "what" of your product, and in case of most meats, the "how."

Central to building this brand identity is your story. Your product's story is crucial for distinguishing yourself to customers who are used to purchasing meat and poultry from a supermarket case. Pictures speak much louder than words.

Consistency is the most crucial element to ensuring lasting success at your farmers' market. When marketing meats at the farmers' market, you are starting with many disadvantages. The greatest is the novelty of the product. People aren't used to purchasing their meats at a farmers' market, even those that purchase the majority of their produce there. Purchasing meats doesn't fit as well in some customers' schedule, due to its highly perishable nature. If your product is high quality, every time, these inconveniences will be overlooked by your customers. You are not only competing against the products and pricing of supermarkets; you are competing against their convenience (Silverman, 2003).

3.7.3 Live Freezer Pork Sales

The basis of farm direct marketing is the relationship of trust that develops between producers and consumers. Successful farm direct marketing depends on providing quality products in a clean and customer-friendly environment. Farm direct marketing requires a substantial time commitment. Agripreneurs need to devote long hours, seven-days-a-week to produce and market their products. Considerable time is also needed to develop the close relationships with consumers. In addition, agripreneurs need to be able to manage their time efficiently in order to sell their products at multiple locations such as at the farm gate and farmers' markets.
Freezer pork is a specialty niche product such as organic, natural and pastured, and usually sold direct to the consumer. It may be sold by the cut or as boxed pork, where the cuts from a quarter or side of the animal are sold as a unit.

Some producers bundle several cuts together to optimize sales of all cuts. Examples of bundles include:

- barbeque pack (chops, tenderloin, steaks and kabobs)
- winter comfort pack (stew meat, roasts, ham and ribs)

- meal in a minute pack (chops, sausages and stirfry meat)
- breakfast pack (sausages, bacon and ham

Typically, the producer might sell the swine by live weight to a customer, then take the swine to a government-approved slaughtering and processing plant. The customer then picks up the pork from the plant and pays for the processing and packaging. But before beginning live freezer sales, the producer needs to form a good working relationship with the processing and packaging facility. Klober, (1998) in an article Small Farm Today suggests several points to consider.

- The facility needs to be close to both your location and the market area.
- It should be a clean, regularly inspected facility.
- The facility operator will need to be willing to work with buyers who have little knowledge of processing, and who will probably do most of their business on a weekend. (There are people who think a swine is all chops.) The facility needs to be willing to handle special orders.
- Cut, size, selections, packaging, package weight, and other processing steps (slicing, smoking, curing, etc.) should be written down and fully understood by all parties.

There are several reasons for producers to sell freezer pork. One reason is to increase the dollar return per animal. In the commodity marketplace farmers accept the price of the day. Selling direct to consumers allows producers to set a price that covers costs and provides a profit. Many consumers are prepared to pay a premium for freezer pork if they know and trust the producer, as well as the producer's animal management practices and products.

Another reason to sell freezer pork is to get a consistent price. It is not uncommon for hog prices to fluctuate over 100 per cent from one season to the next. Selling freezer pork allows producers to even out price fluctuations, as well as cover costs and realize a profit. A growing number of consumers are purchasing pork products direct from the farmer because these products are:

- Organic
- hormone-free
- lean
- locally produced
- pastured rather than grain fed
- antibiotic free
- raised on a heritage ranch

Farm direct marketing provides more income to the producer while the consumer receives a product that is generally not available in the store. A bonus to this type of selling is that some producers find what they like and are good at both marketing and production.

Other direct marketing channels available to swine producers are as follows:

Direct Sale from Farm to Harvest: While most producers today direct market their top hogs by negotiating directly with a packer, it is estimated that only 20 percent or less of cull sows, boars, and secondary market pigs are sold this way. These secondary market hogs, composed predominantly of light hogs, are shipped direct to a packer from the farm, but may include a stop at a secondary collection point where sort and/or further finishing can be accomplished.

Packer Sales through Dealer Networks: An area that has changed dramatically in the past 40 years is the sale of market hogs that arrive at a packing plant, but do not meet top hog specifications. Most of this marketing now occurs through a dealer network. Packers identify these secondary market pigs at the plant and sell them to dealers who then re-sell them through a secondary or alternative market channel. The majority of these hogs are transferred first to a dealer's buying station or collection point where the pigs are sorted and accumulated until a critical mass is met to market the hogs efficiently and effectively. In the past, more secondary market hogs, and even cull sows and boars, arrived at the plant with a load of top hogs. This does not happen as often now since most of these pigs are identified, sorted, and shipped separately.

Auction Market Sales: Auction market sales where pigs go directly to harvest from an auction barn are also declining. Most of these pigs now are purchased by a dealer at the auction barn and marketed through a dealer network. This usually includes at least one temporary transfer to a dealer's buying station or collection point.

3.8 Indirect Marketing

In the context of marketing there are two types of marketing, direct and indirect. The channel in which there is no direct communication to customers by the companies is called indirect marketing. Basically, it is treated as the next stage for brand recognition and awareness.

When customers are aware of the product and only require to be reminded about the product then indirect marketing will be used. Indirect marketing is generic in nature and no segmentation and targeting is required. The retention to customers is made by presenting them in symbolic representation without discriminating within the customers. In indirect marketing

we cannot record the immediate response of the customers but questionnaire can be used to take response in future.

Indirect marketing is the distribution of products through an intermediary (ies) or channel(s) to the ultimate customer/consumer. It is also a way that most business does to market their ideas, products or service without using direct marketing and advertising. Some methods of indirect marketing in swine marketing include abattoirs, butcheries, processors, specialist food stores, wholesalers, cooperatives, and retailers.

Indirect channels of distribution could be classified as follows:

- Producer –Abattoir – Consumers
- Producer – Butcheries – Wholesaler – Consumers
- Producer – Processors – Specialist Food Stores – Consumers
- Producer – Butcheries –Cooperative – Retailers – Consumers
- Producer – Abattoir – Butcheries – Processors – Wholesalers – Retailers – Consumers

In an indirect marketing situation, the intermediary receives a percentage or commission of the sale. In most cases, indirect marketing involves a producer taking the product to a livestock sale barn, production sale, or herd dispersal sale. In any of these situations, an intermediary assist with the sale transaction and receives a commission or percentage from the sale. After the animals leave the sale site, they may move to another farm, sale facility, or processor.

Indirect marketing is fairly simple. Options include a production or specialty sale/auction or the transportation of animals to a livestock sale barn where they are auctioned for the highest bid. In a production or specialty sale, the producer makes arrangements to list his or her animals in a sales catalogue with a sales facilitator several months before the sale date. A modest amount of paper work is involved; terms, fees, and contracts are established long before the sale takes place. Minimum bids may or may not be set before the sale. These types of sales often take place at a livestock show facility. Internet sales are becoming more popular because they bring additional buyers into play. Production or specialty sales generally will bring more money per animal because these types of animals are to be used as breeding stock or show animals, and buyers are willing to pay more for high-quality animals. In this situation, the seller has no control over prices bid by potential buyers.

In a sale barn situation, the animals are delivered by the seller to a local livestock sale barn. Upon delivery, the animals are identified (tagged) based on seller; graded or sorted according to weight, age, or visual evaluation; and placed in pens until the auction begins. Sellers sit in the audience and observe the bidding process or they may leave after dropping off their animals and receiving a receipt. As each animal or group of animals enters the ring, the auctioneer calls off prices and buyers in the audience will bid. The sale price is determined by the buyers in the audience. If there are not any serious or commercial buyers, the bid prices may be low. If there are serious individual buyers and commercial buyers, the bid prices will likely be driven upwards. Prices bid by commercial buyers may be affected by potential market demand and possible excessive supply. During peak market demand and upcoming ethnic holidays, prices will increase. During the summer, bid prices are generally low because demand is lower and supply is plentiful. In a sale barn situation, the seller has no control over bid prices.

In an indirect market, a portion of the money from the final sale goes to the intermediary and the remainder to the producers, so it is likely the amount the producer receives is less than a direct sale. After all, final buyers are not willing to pay extra because an intermediary was involved. Indirect marketing involves a service, and intermediaries expect to receive fair compensation for their services. Indirect marketing is a fairly simple process with little involvement on the part of the producer.

Indirect marketing is any form that doesn't try and sell something directly to consumers, but rather allows businesses to build relationships with them. In general, indirect methods of marketing serve two purposes:

1) They help pave the way to perform direct campaigns later: By posting blogs and responding to comments, or by engaging with potential consumers on social media sites, you are getting to know your audience better. This gives insight into what they want and need, what sorts of products they want, and which of your products they would be most interested in purchasing.
2) It brings new customers to you indirectly: Even if you never reach out to potential consumers directly, your indirect marketing methods can bring them to you. If someone in need of our product or service happens upon your blog, he may just shoot you an email to see if you'd be interested in working together. The same holds true for optimization of a website and social media pages. Clients can find you almost anywhere if you remain active enough.

In the first scenario, where you use indirect methods to pave the way for future direct campaigns, you are working in a more calculated way. That means if you intend to use your interactions from these methods for a long-term marketing plan, you will need to be more active in keeping track of information.

In indirect channels of distribution there are one or more middlemen between the manufacturer and consumers. There is no direct contact between the producers and the customers. Indirect channels of distribution may be classified as follows:

- Producer-Customer: - This is the simplest and shortest channel in which no middlemen is involved and producers directly sell their products to the consumers. It is fast and economical channel of distribution. Under it, the producer or entrepreneur performs all the marketing activities himself and has full control over distribution. A producer may sell directly to consumers through door-to-door salesmen, direct mail or through his own retail stores. Big firms adopt this channel to cut distribution costs and to sell industrial products of high value. Small producers and producers of perishable commodities also sell directly to local consumers.
- Producer-Retailer-Customer: - This channel of distribution involves only one middleman called 'retailer'. Under it, the producer sells his product to big retailers (or retailers who buy goods in large quantities) who in turn sell to the ultimate consumers. This channel relieves the manufacturer from burden of selling the goods himself and at the same time gives him control over the process of distribution. This is often suited for distribution of consumer durables and products of high value.
- Producer-Wholesaler-Retailer-Customer: - This is the most common and traditional channel of distribution. Under it, two middlemen i.e. wholesalers and retailers are involved. Here, the producer sells his product to wholesalers, who in turn sell it to retailers. And retailers finally sell the product to the ultimate consumers. This channel is suitable for the producers having limited finance, narrow product line and who needed expert services and promotional support of wholesalers. This is mostly used for the products with widely scattered market.
- Producer-Agent-Wholesaler-Retailer-Customer: This is the longest channel of distribution in which three middlemen are involved. This is used when the producer wants to be fully relieved of the problem of distribution and thus hands over his entire output to the selling agents. The agents distribute the product among a few wholesalers. Each wholesaler distributes the product among a number of retailers who finally sell it

to the ultimate consumers. This channel is suitable for wider distribution of various industrial products.

An entrepreneur has to choose a suitable channel of distribution for his product such that the channel chosen is flexible, effective and consistent with the declared marketing policies and programmes of the firm. While selecting a distribution channel, the entrepreneur should compare the costs, sales volume and profits expected from alternative channels of distribution and take into account the following factors:

- Product Consideration: - The type and the nature of products manufactured is one of the important elements in choosing the distribution channel. The major product related factors are: -
- Products of low unit value and of common use are generally sold through middlemen. Whereas, expensive consumer goods and industrial products are sold directly by the producer himself.
- Perishable products; products subjected to frequent changes in fashion or style as well as heavy and bulky products follow relatively shorter routes and are generally distributed directly to minimise costs.
- Industrial products requiring demonstration, installation and after sale service are often sold directly to the consumers. While the consumer products of technical nature are generally sold through retailers.
- An entrepreneur producing a wide range of products may find it economical to set up his own retail outlets and sell directly to the consumers. On the other hand, firms producing a narrow range of products may their products distribute through wholesalers and retailers.
- A new product needs greater promotional efforts in the initial stages and hence few middlemen may be required.
- Market Consideration: - Another important factor influencing the choice of distribution channel is the nature of the target market. Some of the important features in this respect are: -
    - If the market for the product is meant for industrial users, the channel of distribution will not need any middlemen because they buy the product in large quantities. While in the case of the goods meant for domestic consumers, middlemen may have to be involved.

- If the number of prospective customers is small or the market for the product is geographically located in a limited area, direct selling is more suitable. While in case of a large number of potential customers, use of middlemen becomes necessary.
- If the customers place order for the product in big lots, direct selling is preferred. But, if the product is sold in small quantities, middlemen are used to distribute such products.

Other Considerations: - There are several other factors that an entrepreneur must take into account while choosing a distribution channel. Some of these are as follows: -

- A new business firm may need to involve one or more middlemen in order to promote its product, while a well-established firm with a good market standing may sell its product directly to the consumers.
- A small firm which cannot invest in setting up its own distribution network has to depend on middlemen for selling its product. On the other hand, a large firm can establish its own retail outlets.
- The distribution costs of each channel are also an important factor because it affects the price of the final product. Generally, a less expensive channel is preferred. But sometimes, a channel which is more convenient to the customers is preferred even if it is more expensive.
- If the demand for the product is high, a greater number of channels may be used to profitably distribute the product to maximum number of customers. But if the demand is low only a few channels would be sufficient.
- The nature and the type of the middlemen required by the firm and its availability also affect the choice of the distribution channel. A company prefers a middleman who can maximise the volume of sales of their product and also offers other services like storage, promotion as well as after sales services. When the desired type of middlemen is not available, the manufacturer will have to establish his own distribution network.

All these factors or considerations affecting the choice of a distribution channel are inter-related and interdependent. Hence, an entrepreneur must choose the most efficient and cost effective channel of distribution by taking into account all these factors as a whole in the light of the prevailing economic conditions. Such a decision is very important for a business to sustain long term profitability.

3.9 Niche Marketing

Swine producers can develop niche markets for their pork by emphasizing the animal welfare benefits or environmentally friendly aspects of their systems.

A survey of Colorado, Utah and New Mexico grocery shoppers determined that many – especially high-income frequent pork consumers and those concerned about growth hormones and antibiotic use – are willing to pay a premium. 'These target consumers are very concerned about the production practices utilized by the producers,' (Grannis & Thilmany, 1999). A highly visible and descriptive label that highlights production practices must be part of the packaging.' Research funded by the Leopold Center at Ames, Iowa, found that consumers would pay nearly $1 more for a package of pork chops labeled as produced under an environmentally friendly alternative system. (The study defined the 'most environmentally raised pork product' as being produced in a way that result in 80 to 90 percent odor abatement and 40 to 50 percent reduction in surface water pollution.) The study by ISU economics professor James Kliebenstein surveyed randomly selected consumers in four diverse market areas. Of those, 62 percent said they would pay a premium for pork raised with such a guarantee. (Sustainable Agriculture Research & Education, 2012)

The economic pressures faced by small-scale swine producers have caused many to quit the business, unable to compete with larger, more cost-efficient operations. The changing structure of the swine industry has fostered the creation of new markets and interest by swine producers in considering alternatives to the traditional commodity system.

Niche marketing is targeting a product or service to a small market segment that is not being served or in which demand has not exceeded supply. Niche marketing could be defined as concentrating all marketing efforts on a small but specific and well-defined segment of the population. Niches do not 'exist' but are 'created' by identifying needs, wants, and requirements that are being addressed poorly or not at all by other firms, and developing and delivering goods or services to satisfy them. As a strategy, niche marketing is aimed at being a big fish in a small pond instead of being a small fish in a big pond. A market niche can be identified as a geographical area, a specific industry, ethnic group or a particular age group. An ethnic market is a group of consumers that share a common cultural background

A niche market is the subset of the market on which a specific product is focusing. The market niche defines the product features aimed at satisfying specific market needs, as well as the price range, production quality and the demographics that is intended to impact. It is also a

small market segment. Every product can be defined by its market niche. The niche market is highly specialized, aiming to survive among the competition from numerous super companies. Even established companies create products for different niches, for example, Hewlett-Packard has all-in-one machines for printing, scanning and faxing targeted for the home office niche while at the same time having separate machines with one of these functions for big businesses.

3.9.1 Niche Marketing Opportunity

Consumers have recently shown a surge of interest in purchasing pork and other agricultural products that are not produced by corporations or those using large-scale farming techniques, for example, the use of antibiotics or pesticides. Producers who market this “niche pork” have a long way to go before they can satisfy consumer expectations, particularly in terms of product identification and traceability.

Farmers’ markets are the best examples of these alternative markets, and they are becoming increasingly common across the U.S. Selling pork at old-fashioned roadside stands, directly to specialty restaurants, and more recently, directly to consumers on the Internet all allow farmers to brand their product for niche market. Farmers’ markets are now an established link between consumers and farmers. Certain consumers want locally grown fresh food and will pay more to connect directly with the producers. Fruits, vegetables, and other horticultural crops currently dominate the market, but meat sales are rising and present a major opportunity for pork producers. More people are becoming aware of the importance of swine products. Farmers’ markets are generally organized and run by participating farmers.

For farmers to penetrate niche markets and prosper, they need to explore new opportunities. Some producers have done well by capturing the market of restaurants in the city; others routinely sell swine for BBQ pigs; still others have established less formal buying clubs. While the CSA option is currently dominated by the fruit and vegetable sector, the opportunity to sell pork is ready and waiting for entrepreneurs.

3.9.2 Commodity Versus Niche Marketing

Successful marketing is a necessary part of any profitable enterprise, and alternative marketing is often necessary for sustainable hog producers to survive. Unfortunately, farmers who practice sustainable and humane hog production often neglect marketing. Sustainable hog producers need to realize that successful marketing efforts will likely be as management-intensive as their production systems and that those efforts will be directed toward specialty

and niche markets, not the conventional commodity market and distribution network. There is an opportunity for producers of value-added and premium pork products to realize sustainable profits, but only if they are willing to develop the necessary marketing skills.

Before sustainable hog producers decide to pursue alternative marketing, they need to understand the differences between commodity and niche marketing. Commodity marketing is marketing hogs that are undifferentiated from other hogs in the mass market. Niche marketing is differentiating your pork product to a market that wants a unique or superior product. Commodity marketing is marketing hogs that are un-differentiated from other hogs in the mass market. Niche marketing is differentiating your pork product to a market that wants a unique or superior product. Niche marketing can either be done by working through others, a cooperative, a private label brand, or directly to individuals. It can Involve freezer meat sales, home delivery, farm meat stores, farmers markets, internet sales, sales to restaurants, groceries and/or specialty food stores.

A commodity is an article of commerce or trade that is in demand and sold by various suppliers without any qualitative differentiation. It is a product that is the same no matter who produces it, such as petroleum, notebook paper, or milk. The commodity market is a geographical location where the seller and buyer meet to transfer the ownership of goods from the former to the latter through negotiation at mutually agreed value. For a commodity market to be functioning, the important ingredients are commodity, buyer and seller. The market place may be organized or unorganized depending upon the aggregation of the buyer and seller at certain geographical location and at a certain given time. With the development of various means of communication, development of storage system, better means of transportation and the advanced form of payment has broadened the definition of the commodity market.

Commodity is divided in various categories based on the source of production like Agri and Non-Agri. Non-Agri commodity is again divided among metals and energy. Metals are divided into precious such as steel, copper etc. Based on the storability factor, like perishable items include vegetables, fruits and milk and non-perishable items include metals or semi perishable like cereals and pulses. World-over, one will find that a market exits for almost all the commodities known to us. These commodities can be broadly classified into the following:

The commodity markets have their origins in the ancient civilization of Sumer in southern Iraq. Tokens were used to trade commodities. This included specific timeframes and the delivery of commodities, just like contemporary futures contracts. By the 19 century, the crude

commodity markets paved the way for modern, regulated and standardized markets in the US, where agricultural products and cattle were traded. The modern commodity markets have their roots in the traded. The modern commodity markets have their roots in the trading of agricultural products.

The commodities market exits in two distinct forms namely the over the counter (OTC) market and the exchange-based market. The OTC markets are essentially spot markets and are localized for specific commodities. Almost all the trading that takes place in these markets is delivery based. The spot markets are essentially over the counter markets and the participation is restricted to people who are involved with that commodity say the farmer, processor, wholesaler etc. In addition to the spot transactions, forward deals also take place in these markets. However, they too happen on a delivery basis and hence are restricted to the participants in the spot markets. Majority of the derivative trading takes place through exchange – based markets which is called futures commodity market, with standardized contracts, settlements etc.

The methods of trade, market structure and profile of market participants are different in physical and derivative markets.

3.10 Sow Marketing

A sow is a female swine that has farrowed or given birth to one or more litters or piglets. Most sows have fewer pigs as they age past their 6^{th} or 8^{th} litter, and are candidate to be culled. At this stage they become weak and cannot be productive. They consume more food thereby adding extra cost to the farmer. Older larger sows often will not fit into a conventional farrowing crate, have nipples too large for the piglets to place in their mouths, or have rows of nipples soared too far apart for baby piglets to nurse the top row. All of these are reasons to cull a sow. At this stage the farmer decides to sell them off.

Sow marketing is the disposal of unproductive adult female swine. There are possible strategies that the farmer could employ in sow marketing. The farmer could sale at the farmer's market or at the gate farm. He can employ both direct and indirect marketing strategies. In direct marketing, he could sale to friends/neighbours, internet marketing, restaurant, grocery stores etc. In indirect marketing strategy, he could sale to abattoir operator who in turn sales to butchery/or wholesaler/or retailer to the ultimate consumer. The farmer can employ any of the strategies depending on the circumstance on ground.

3.11 Feeder Swine Marketing Techniques

Currently, methods of marketing feeder pigs vary by region. Techniques range from decentralized direct sales between individual feeder pig producers and finishers to more centralized, sophisticated electronic markets. Each method offers unique circumstances and challenges for the feeder pig producer and/or buyer. The most prevalent marketing methods include the following:

3.11.1 Direct feeder pig producer to feeder pig finisher

The producer may advertise feeder pigs locally to attract interested buyers or the producer may develop long term supply relationships with one or more buyers. Price is generally negotiated and, in instances of longer-term contractual arrangements, may be established using an agreed upon formula price. These formulas often are based on a nearby or benchmark public price. Determining a fair formula can be difficult, especially if the quality of the pigs being sold differs substantially from the average at the public markets. Many public markets no longer report prices. Both sellers and buyers need to be informed of market conditions and have a means to determine the economic value of the pigs in order to settle upon a fair price.

3.11.2 Public auction

A producer brings or consigns pigs to the livestock auction operated by a firm or farmer owned marketing cooperative. Pigs may be sold as delivered or graded and pooled for sale to buyers. Pigs graded into uniform-graded lots are attractive to buyers. Pigs are sold to the highest bidder and price depends upon buyer demand. Generally, once pigs enter the sale ring they are sold without opportunity for withdrawal by the seller.

3.11.3 Electronic auction

Electronic auction selling has gained increased popularity in recent years with the opening of an electronic auction by Central Livestock Association in St. Paul, Minnesota. Prospective feeder pig sellers' herds are health inspected and the seller is certified by the auction association. Feeder pigs offered for sale are scored based on health programs, feeding programs, and herd management. This information along with the identification of the seller is made available to prospective buyers via computer modems. Consigned feeder pigs can be reviewed by potential buyers who then participate in an open auction as each pen is offered for sale. No commingling or central collection of the feeder pigs occurs. Pigs move directly from the seller to the buyer. For a consignment fee seller reserve the right to withdraw pigs from the auction and declare a

no sell. Likewise, feeder pigs that are not accurately represented or do not meet weight and grade specifications are either price adjusted at delivery or may be rejected in extreme circumstances by the buyer.

Credit checks are run on buyers to insure payment. This market potentially expands the number and geographic dispersion of both sellers and buyers relative to other market alternatives. Feeder pig producers considering this type of market should closely investigate the process and clauses for the particular market they are investigating. This marketing method offers potential benefits to both buyers and sellers if properly designed and operated (DiPietre et al., 2010).
The alternatives for marketing feeder swine and slaughter swine from small-scale or part-time farms according to (Harper et al., 2013) include:

- Finishing pig producers
- Livestock auctions
- Graded feeder pig sales
- Buying stations
- Direct sales to order buyers (on-farm market sales)
- Small packers/processors
- Specialty sales direct to consumers

All of the above listed options are available to any feeder swine producers. One of the most popular options is marketing directly to producers who finish swine. This option has advantages for both parties. First, the buyer and seller know the price and delivery conditions in advance. Second, the direct-sale option reduces animal stress and disease risk. Third, the direct-to-finisher transaction voids commissions associated with a livestock auction.

Marketing feeder swine through a livestock auction, a graded sale, or a buying station are other common options. Before using these markets, the producers should know the desirable weights and lot sizes that maximize prices received.

3.12 Overview of the South African Swine Marketing Trend

The South Africa agricultural sector is dualistic with commercial sector co–existing with traditional subsistence sector. The subsistence sector involves small-scale production, highly labour intensive with low capital intensity and little division of labour. The commercial sector on the other hand involves high capital intensity, high levels division of labour and patronize

both local and international markets. This concept of dualism system has created an unequal distribution of land, economic assets, support services, market access, infrastructure and income in all sectors of the economy (Ghatak & Intersent, 1984).

Agricultural practices are one method of alleviating poverty in rural areas. In developing countries, agriculture plays an important role in the livelihoods of individuals through the production of agricultural goods for consumption and income. Although agriculture is important, many are still skeptical about the contribution of small and emerging farmers to the economy as compared to commercial farmers. The limited contributions to the economy by emerging farmers arise due to the constraints faced by the farmers which are many and varied: marketing, financial, technical, economic, land, social and cultural aspects.

The problem of marketing constraints arises due to many factors such as limited knowledge and use of market information (Kohls & Uhl, 2002), lack of access to high-value reliable markets (Pandey & Tewari, 2004) and high transactional costs. Other factors include: distance from the markets which tends to influence transaction costs, high feed costs (GDACE, 2009), price and competition; lack of appropriate and affordable means of transport (Chaminuka, 2008); poor quality of products (Kemm, 1993; Cole, 1971; lack of storage facilities (Pandey & Tewari, 2004; ohls & Uhl 2002); adverse effects of culture (Cole, 1994) and socio-economic factors (Chaminuka, 2008; Ogunsumi, 2007); low educational levels of small and emerging farmers; agricultural marketing policies imposed, poor agricultural extension services (Jones & Garforth, 1994: Adhikarya 1994: Norton et al., 2006) and lack of financial support (Ghatak & Ingersent, 1984; Brandson & Norvell, 1983; Tracy, 1993).

According to Kohls and Uhl (2002), marketing is a business activity associated with the flow of goods and services from producers to consumers. The marketing of agricultural products begins on the farm, with planning of production to meet specific demand and market prospects. Marketing is completed with sales of the fresh or processed products to consumers or manufactures in case of raw materials for an industry. The South African government's agricultural marketing policies play a crucial role in promoting pig enterprise for emerging farmers. It is through proper marketing channels, government interventions and other agricultural policies that pig industries can grow. Pig farmers in the Gauteng Province have proven capability to sustain and improve the pig industry but this has not been achieved, due to many constraints such as inadequate production infrastructure, high transactional cost, poor marketing channels and barriers to market information.

Demand for pork in Gauteng Province has been increasing rapidly due to increasing income and urbanization. At the small-scale pig holders' forum held in the West Rand area of the Gauteng Province in September 2009, the main constraints as identified by the farmers was in the area of marketing. In the past decade, South African agriculture has experienced major policy changes. The centralized control of agricultural markets has been removed, trade has largely been liberalized and equitable access to services and resources for all groups of the population have been vigorously promoted. Since the deregulation of marketing in South Africa after 1994, the marketing of pork is free with an import tariff applied to all pork products from outside Southern African Customs Union (Vink & Kirsten, 2000).

The Marketing of Agricultural Products Act of 1937, which was amended several times in the 1950s, 1960s and 1980s, was replaced by the Marketing of Agricultural Products Act (1996) which was more concerned with reducing state intervention in agricultural marketing and product prices. The main objectives of the new Act were to provide free market access for all market participants; promote efficiency of marketing of agricultural products; improve opportunities for export earnings and enhance the viability of the agricultural sector. The government focus has now shifted to improving the wellbeing of individuals and securing of the nation's interest (The White Paper on Agriculture 1995).

However, a dual market structure exists in the pig industry: the high-value markets (processors and supermarkets) for commercial pig farmers and low-value markets (local auctions, pension point sales and abattoirs) for the emerging small-scale pig farmers. The large-scale commercial farmers capture the high-value markets that pay premium price for quality products while emerging small scale farmers have limited access to such markets. This trend may be limiting the livelihood opportunities of many emerging farmers in the pig industry hence the need to investigate the extent to which emerging small-scale pig farmers are able to access high-value markets in the pig industry.

South African pork producers are favourably competing with their overseas' counterpart. This is emphasised by the fact that the tariff applicable to pork import is lower than for beef and mutton. Moreover, areas allowed for importation are those that South Africa has shortage (eg spareribs and back fat). On the local market, things are going the pork producer's way in the sense that per capita consumption of pork has remained stable over the years, unlike other red meats where consumptions has declined (SAPPO, 2006). The introduction of Best Management

Practice (BMP), computerised feeding methods and environmental maintenance equipment, improved disease control measures, etc has contributed to the large investment to the industry.

More recent report by the Department of Agriculture, Forestry and Fisheries (Directorate of marketing) of South Africa (2010), reveal that over 2.4 million pigs were slaughtered during 2009 yielding over 186 million kilograms of pork. The report indicates that pigs slaughtered and pork production over the past decade (1999-2009) followed a steady increase. But unfortunately, the demand for pork meat in the country has outweighed the production. The report continued to indicate that in South Africa more pork is consumed than it is produced. In 2009, the production rate was about 180 million, while the consumption rate was 200 million. This trend moved south Africa from being a net exporter of pork to net importer of the same. South Africa has continued to be a net exporter of pork with a specific shortage in sparerib and back fat. On this note, the government allowed the importation of spareribs and back fat to support the local producers.

Like the other red meat products, pork was subject to a surplus removal system when marketing was regulated. Since the deregulation of marketing, the whole structure has changed. Presently, the marketing of pork is free with an import tariff applied to all pork products from outside the SACU. The ratification of the Marrakesh Agreement introduced a whole new era of trade relations between countries. One of the main features of Agreement on Agriculture (AoA), is the abolition of all quantitative import controls and the replacement of these with tariffs.

Since introduction of trade liberalization in 1994, imported poultry became the cheapest animal protein and this affected pork prices which drifted down to poultry import parity prices. However, the fluctuations of the exchange rate and higher duties, imported poultry prices increased. These special offers put a lot of pressures on the local pork producers. It also became advantage to both producers and the marketers (SAPPO).

3.13 South African Market Structure

There are two major market structures inherent in South Africa. They are grouped into Domestic and International market:

(a) Domestic Market: The local market is split at almost 50:50 between the fresh meat market and the processing meat market. The pork industry evolved from a highly regulated environment to one that is totally deregulated today. Various policies, such as the distinction between controlled and uncontrolled areas, compulsory levies payable

by producers, restrictions on the establishment of abattoirs, the compulsory auctioning of carcasses according to grade and mass in controlled areas, the supply control via permits and quotas, the setting of floor prices, removal scheme, etc., characterised the pork industry before deregulation commenced in the early 1990s. Since the deregulation of the agricultural marketing dispensation in 1997, the prices in the red meat industry are determined by demand and supply forces.

(b) International Market: From 2000 to 2009, South Africa's pork exports were far less than the imports. For example, in 2009 there was an export of about 3 million kilograms of pork compared to over 25 million kilograms of pork imported. It was only in 2005 that exports increased substantially above 20 million kilograms. This confirmed that South Africa is a net importer of pork.

South Africa exported approximately 30.2 million kilograms of pork from 2000 to 2009, yielding an export value of R183.6 million over the same period. The report indicated that export value of pork was slightly fluctuating from 2000 to 2005 before increasing substantially from 2006 to 2009. Export value of pork increased by over R40 million in 2009 compared to 1999. South African pork is mainly exported to SADC countries. Mauritius commanded the highest share of South African pork (over 200,000kg) in 2008, followed by Zimbabwe (600,000kg) in 2009. It is noted that South Africa pork is exported within the content, mostly to SADC countries which constitutes 73% of the total pork exported and Nigeria from Western Africa constituted 4%. The general share of provincial pork exports to the total RSA pork exports from 2000 to 2009 is shown in table 3.1 below.

Although South Africa exported pork during the period under review, they still imported a large quantity of same product. South Africa produces around 189 million kilograms of pork and consumes 208 million kilograms. After subtracting the small quantities of exports, the shortfall is imported. It was estimated that the import of pork to South Africa got to a peak of 25,000,000 kilograms worth about R400,000,000 in 2005, while 2009 saw the highest peak of over 26,000,000 kilograms worth over R42,000,000 of pork importation. The large import of pork to South Africa is as a result of higher rate of consumption than the local production rate.

Imports for pork in South Africa during the past decade (1999-2009) were dominated by France, which remained on the top from 2000 to 2008. Belgium was the second supplier from 2000 to 2005 and countries like Denmark, Germany and Spain increased their supply for pork significantly from 2006 to 2009. Other suppliers included Brazil, Canada, Chile and the United

States. Canada had the highest supply of pork to South Africa (49%) in 2009 followed by Germany (18%) and France (16%) (Source: Department of Agriculture, Forestry and Fisheries report, 2010).

Table 3.1: Total RSA Pork Export from 2000 to 2009, Adopted from Pork Marketing Channel (RSA Agricultural, Forestry & Fisheries).

Province	2000	2001	2002	2003	2004	2005	2006	2007	2008
Western Cape	12.41	15.67	23.89	33.34	49.01	20.66	15.93	41.61	33.44
Eastern Cape	0	0	0.02	0	0	0	0	0	0
Free State	0	0	0	0	0	0	0	0	3.3
Kwazulu-Natal	2.84	23.85	25.89	12.16	7.59	3.98	24.54	11.41	2.73
North West	0	0	0	0	0	0	0	0	0
Gauteng	84.61	59.31	50.16	51.25	43.16	75.33	59.53	46.97	60.53
Mpumalanga	0.13	1.17	0.04	3.25	0.25	0.02	0	0	0
Total	100	100	100	100	100	100	100	100	100

Table 3.1 above shows that Gauteng province had the highest share in the export of pork followed by Western Cape and Kwazulu-Natal provinces. This could be attributed to the fact that these provinces are the main exit points for pork. Our study area Free State contributed 3.30% in 2008 and 0.93% in 2009.

3.14 Distribution Channels for the Marketing of Swine

Starting small is probably the best approach for the beginning swine production. Producers need first to determine the best possible channel to adopt in marketing their product. Depending on the focus of the farmer, he/she may decide to sale directly grocery/butchery stores or to consumers. Any channel chosen will determine the effectiveness the sales. For a beginner it might be difficult to penetrate the grocery/or speciality food stores because the stores usually want guaranteed amount of supply which might be difficult for a beginner to meet. These specialist food stores sometimes lock themselves into exclusive contract with large suppliers. Other channels could involve selling frozen pork to friends and neighbours, to home delivery customers, farm meat stores, farmers' markets, and/or restaurants.

Producers also need to consider that many grocery stores have "slotting allowances" for space in their freezers or meat coolers. This may make them too expensive for small producers who do not generate enough turnovers. (Looker, 2003).

The channel begins with the primary producer/farmer. The pigs are slaughtered at the abattoirs. The meat is sold to the butcheries/wholesalers/retailers/processors. The meat can be bought by consumers directly from the abattoirs and/or butcheries and/or wholesalers and/or retailers. In some cases, the consumers buy live pig directly from the farmer and perform abattoir and processing activities him-/herself.

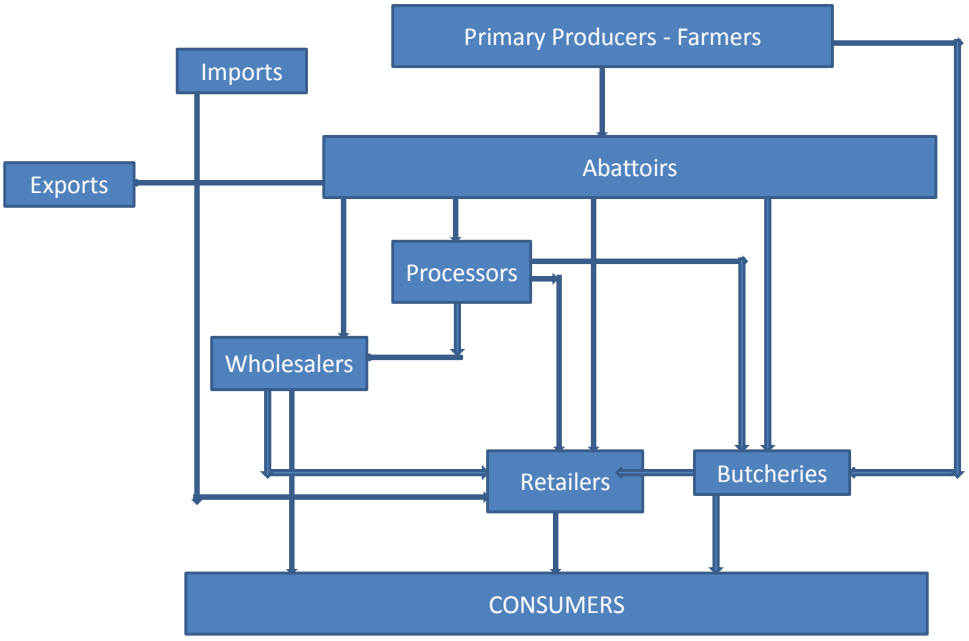


Fig.: 3.1 Adopted from Pork Marketing Channel (RSA Agricultural, Forestry & Fisheries).

3.15 Developing a Swine Marketing Plan

Agricultural producers often live up to their name. They are very good producers, but they often lack skills to be good marketers. Marketing and market planning to secure the best price for hogs sold and inputs purchased with an acceptable level of risk are an important part of management.

Many of the exciting advancements in technology and opportunities for improvement are in production, but most pork operations can also benefit from improved marketing. However, unlike production efficiency, market prices are largely beyond the control of the manager. What

is under the manager's control is how he or she chooses to deal with market prices and price risk that the firm faces. Developing a marketing plan forces the manager to address the marketing questions that are crucial to the firm. Market planning should incorporate several aspects of marketing, including:

- what and how much is being produced,
- when will it be marketed,
- where will it be sold (delivered), and
- how will it be priced (how and when is payment made), etc.

These factors have an impact on the business plan through the cash flow, ability to withstand risk, and price relative to cost of production.

The first step to manage marketing is developing the marketing plan. A written plan makes implementation easier and is an important communication tool for use within the firm as well as with external audiences such as lenders. The process of developing the written marketing plan is also crucial and should be viewed as an investment in the business. Marketing plans are unique to each operation because they incorporate the constraints and opportunities of the firm as well as the financial and personal characteristics of the manager. As a result, marketing plans are custom tailored, not "one-size-fits-all." In spite of this individuality, marketing plans can be developed around a general outline.

The first step in developing a marketing plan is to describe your current operation. Characteristics of the operation important to the marketing plan may include the following:

- Annual marketing: number (market hogs, feeder pigs, breeding herd), weight, timing of sales
- Input purchases: feed needs, when and how much
- Quality of hogs: genetics, lean (average and distribution), weight distribution (sort)
- Cost of production: direct and total costs
- Alternative market outlets: name, distance, transportation costs
- Marketing philosophy: sell on tight schedule, shop for best price, standing order
- Attitude: toward price risks and knowledge of risk management tools.

Goals should be achievable and measurable. Once they are consistently met, they should be revised upward. For example, the goal may be to receive a barrow and gilt net selling price that

is ten percent higher than the state average for the year. The goal is measurable because it can be compared to the reported state average price. It is also achievable through selling leaner-than-average hogs, better sorting, plant delivery, using futures and options, or joining a marketing network.

The goal is also long-term because any one load of hogs may sell for less (fast-growing barrows tend to be fatter, non-uniform pigs are discounted; sort loss may be high with all-in-all-out finishing). Depending on where you begin, your goal may be lowered. Other goals may be to achieve an annual average corn and soybean meal price that is less than the annual average price, or to increase average market weight of pigs to 250 pounds and reduce sort loss to less than R0.30/cwt.

Goals should be set carefully to ensure that they are really what you want to achieve. For example, is selling half of your barrows over 56 percent lean the goal if they are cost-probative to produce in your facilities? Goals may change over time, but they should not be so fluid that they are ignored. The number of marketing goals listed at one time should be limited and, when possible, be consistent.

After identifying marketing goals that are consistent with your business goals, a plan must be developed to achieve them. This is where the map becomes important. You are currently in Boston and your goal is to reach Dallas. What roads do you take? These short-term navigations directed at the long-term goal are marketing objectives.

Like goals, objectives should be realistic, measurable, and achievable. Objectives have a shorter-term focus, and incorporate current production and market conditions and projections specific to a particular set of hogs or inputs. For example, what are the objectives for June through September corn needs or October hog marketing? You should be able to quantify how much corn you will need during those months and how many hogs you will sell in October. You will also have information about market conditions, futures market prices, and outlook. From this information you can choose a route that will move you closer to your destination or at least reduce the amount of backtracking.

Besides long-term goals relating to growth and profitability, objectives also must meet short-term cash flow needs consistent with current market and financial conditions. For example, hedging an October price that covers cash costs and assures enough income to cover a loan

payment due that month may be a good short-run decision, even though it does not comply with your goal of hedging only if a R15/cwt. profit or greater is offered.

Like a road map, objectives should also be detailed. They may refer to a marketing year, but should also be broken down to specific time and/or product within that period. Objectives should have some basis. Cost of production and profit targets provide tangible benchmarks on which to base objectives. This approach also offers an increasing series of price objectives: direct cost, total cost, total cost plus R2/cwt. profit, total cost plus R4/cwt. profit, etc. Managers should also identify risk objectives for a particular time or group. These objectives may state the acceptable probability of failing to achieve a particular price objective to avoid running down the business.

Beyond objectives, the marketing plan should provide decision triggers and actions to take once the trigger is hit. Given your price and risk objectives, the marketing plan may call for selling a futures contract on half of October's production if its price, adjusted for basis, falls below total cost. The price objectives based upon cost of production identify the futures price that would trigger the risk objective. The marketing plan identified the action necessary to meet the objective.

A marketing plan should be flexible enough to react to changing market conditions. However, without triggers, specific actions to implement, and contingency plans, a marketing plan is of little value. Contingency plans evaluate possible scenarios and develop a set of triggers and action plans for each scenario.

Marketing plans should be evaluated to determine if the objectives were met and if the results were consistent with the long-run marketing goals. When evaluating a marketing plan or marketing decisions, evaluate the results against your objectives-not against perfect hindsight. Often, marketing decisions that met the objectives of the manager at the time they were made are compared with prices they could have had. If the only measure of a marketing decision is whether it hit the top of the market, you will be disappointed.

Marketing is an important part of profitable pork production, but it has often been ignored because it was considered to be out of the producer's control. While individual producers cannot change hog or input prices, they can alter the impact changing prices have on their operation.

The first step in effective marketing is to define it in the context of your operation by setting goals and objectives to achieve those goals. The components of cost of production and profit targets serve as a basis for price objectives. Cash flow, financial strength, past market performance, and personal preference can be used to identify risk objectives. Regardless of the amount of planning, implementation of the plan will determine its success or failure. Implementation requires identified triggers and the appropriate action required when the trigger is hit.

Scope of Cull Sows, Cull Boars and Secondary Pig Marketing Channels

Top hogs are hogs that meet specific qualifications set by major packers. Top hog sales make up approximately 94 percent of total pig harvest. The remaining 6 percent of pigs represent the secondary or alternative pig harvest. This market includes cull sows, cull boars and secondary market hogs that do not fit top hog qualifications and are sold through alternative or secondary cull market channels.

In 2016, cull sows comprised 2.4 percent of total harvest and cull boars comprised 0.3 percent of total harvest. While the percent of boars harvested in the past five years has remained constant, the percent of cull sows has dropped. It was at 2.7 percent in 2012. Prior to the adoption of artificial insemination technology, the percent of cull boars was somewhat higher (Dan Sutherland, 2017).

Most Canadian sows and boars culled in Canada are harvested in the United States. Reported Canadian harvest indicates that boar harvest is non-existent and sow harvest is less than 80,000 head per year.

Light hogs, roasting pigs, and other culled livestock, which are considered secondary market hogs, make up the remaining secondary or alternative pig harvest. Neither USDA nor private industry reports these numbers, so I estimate this to be approximately 3 percent of total slaughter. With more than 110 million hogs marketed in the United States annually, the total number of cull sows, boars and secondary pigs marketed is significant.

The ages of cull sows, boars and secondary market pigs varies from weeks-old weaner pigs harvested for roasters to cull boars and sows that could approach seven years of age. The age and number within groups are determined by many cull marketing decisions including disease,

cull residual value, re-population efforts, and market conditions. Routine marketing of cull sows from most herds is determined by breeding herd performance.

CHAPTER 4

SWINE MARKETING MODELS

4.1 Introduction

Marketing is an important aspect of any livestock system. It provides the mechanism whereby producers exchange their livestock and livestock products for cash. The cash is used for acquiring goods and services which they do not produce themselves, in order to satisfy a variety of needs ranging from food items, clothing, medication and schooling to the purchase of breeding stock and other production inputs and supplies.

Policy and decision makers have to make difficult choices to streamline issues around climate change, food security, energy supply, globalisation of markets, population and economic growth, and declining natural resources. Ex-ante impact assessment using integrated models that systematically link development pathways with biophysical and socioeconomic processes and characteristics offers them a decision support tool to help with these decisions. However, these models need to integrate relationships across disciplines, levels of organisation and scales (Ewert et al., 2011). This chapter gives an overview of different swine marketing models adopted by different researchers at different time period. The chapter considers the following swine marketing models including: Rule of Thumb marketing model; The Structure – Conduct – Performance model; Commodity Chain model; Transaction Cost model; Stochastic model for swine marketing, and Spreadsheet Marketing model.

Up to now modeling efforts have focused on specific aspects of policy, market and land systems (Dalgaard et al., 2011). Current approaches either use top-down global and continental approaches (e.g. macro-economics and large scale land use modeling (Creutzig et al., 2012; Zhang et al., 2013) or bottom-up approaches, from farm level upwards (farm household modeling, micro-economics, agent based models and landscape level land use modeling) (Rufino et al., 2011; Parker et al., 2003; Valdivia et al., 2012). Existing models do not sufficiently capture the complexity of human–environment interactions across different scales, and especially the link between landscape and local market levels, and national and sub-national level policies and markets is missing (Ewert et al., 2011; Creutzig et al., 2012; Rounsevell et al., 2012). Existing approaches to assess the consequences of global or regional market models on farm household level, take simplistic approaches to represent farmer's diversity and also ignore the diversity in local markets and their effects on price formation. Bottom-up approaches that take into account crop and livestock productivity and analyse food security of farm households

take either a landscape approach (e.g. in many multi-agent models or in land use models) (e.g. Parker 2003) or in a few cases perform a micro-economic analysis including feedbacks between household choices for production of different commodities and price formation at local markets (Valdivia., 2012; Laborte., 2007; Straatman, 2013), but do not go beyond the landscape/local market level.

4.2 Existing Marketing Model for Livestock Distribution

A schematic representation of a livestock marketing system is shown in Fig 4.1. The bottom part shows the flow of livestock from producers to secondary (regional) and terminal (national) markets through one or more primary collection markets.

The top of Fig. 4.1 shows the external and internal factors that influence the livestock marketing system. First on the supply side the cash needs of producers, the strength of demand for their livestock, and pastoralists' expectation of the nature and length of the dry and wet seasons influence the volume of the different species of livestock on offer at any time. The higher the cash needs of the pastoralists the greater the volume of livestock on offer. Their response to market demand has been a subject of controversy in the literature (Carlisle and Randag, 1970; Hill, 1970; Khalifa and Simpson, 1972; Low 1979; Jarvis, 1980). However, there is growing evidence that pastoralists in fact dispose of their marketable animals in a manner consistent with sound economic behaviour (Ariza Nino, 1980).

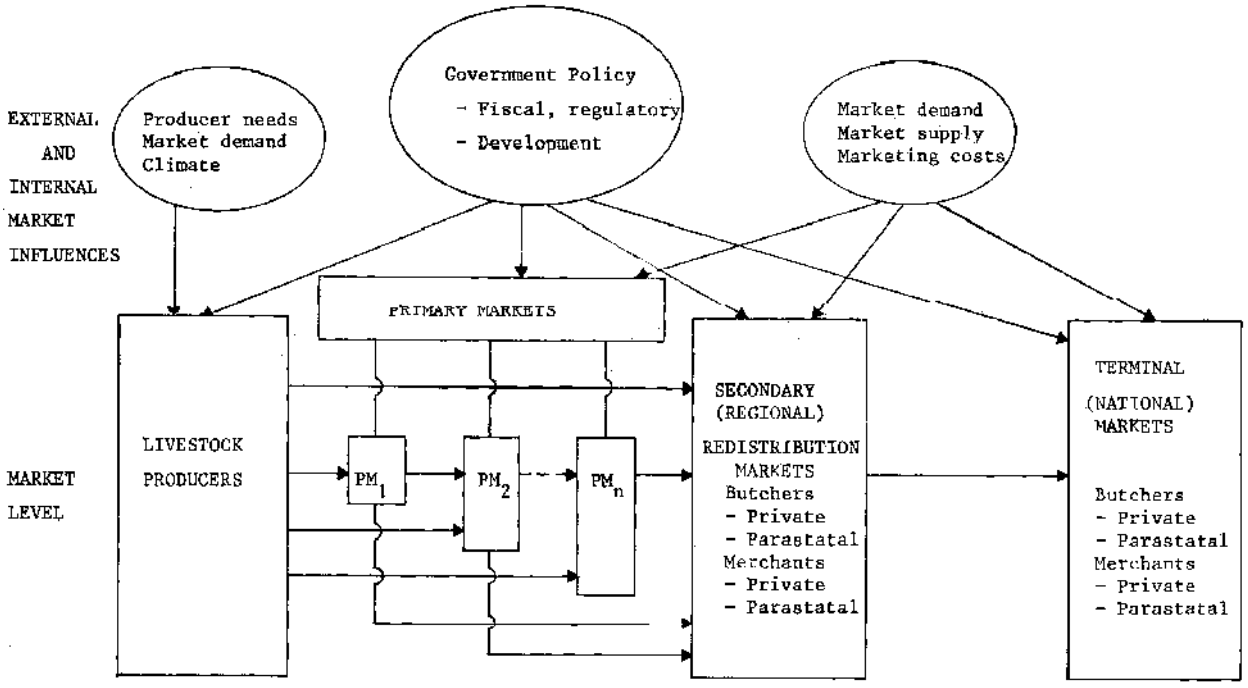


Fig. 4.1 Livestock Marketing System Model adapted from Solomon and Negussie (1983) Livestock Marketing Studies (Eastern and Southern Africa) Program, ILCA Kenya, pp. 327-332 in

Pastoral System Research in Sub-Saharan Africa: Proceedings of the (IDRC) workshop held at ILCA, Addis Ababa Ethiopia 21-24 March, 1983

In other words, the stronger the effective market demand as expressed by high prices, the greater the volume of livestock supplied. Finally, pastoralists' perception of the climate influences supply and hence the price of livestock. Anticipation and occurrence of prolonged dry seasons induce more sales. The poor condition of the animals plus the greater numbers supplied during such times depress livestock prices. On the other hand, the anticipation and occurrence of good raids causes pastoralists to withhold animals from the market so that they can put more weight and fetch better prices later on.

Second, government policy through fiscal, regulatory and development intervention affects the volume, flow and prices of livestock in the marketing system. Favorable fiscal policies that encourage livestock production and reduce costs to producers increase the supply of livestock, e.g. subsidies, and price stabilisation policies. On the other hand, taxes and levies of all kinds tend to restrict the volume supplied. The control of epidemic diseases, the proper development of range areas and the development of trek routes and livestock market facilities tend to increase the volume supplied and reduce marketing costs. In general government monopolistic tendencies and the fixing of artificially low prices stifle market supply and demand.

Finally, market demand as expressed by the volume and prices buyers are willing to pay for livestock influences the behaviour of the markets at all links in the system. The efficiency of the market as reflected by the marketing costs of the system and to what extent price changes are transmitted through the marketing system strongly influences the operation of the markets. The less efficient the market the less responsive will supply be to changes in market demand. Livestock markets can easily be differentiated by the type of sellers and buyers operating in the market and the purpose for which livestock are purchased. Table 1 summarizes the attributes for three types of livestock markets (Ariza Nino et al, 1980).

4.3 Rule of Thumb Marketing Model

Rule of Thumb is seen as a guideline that provides simplified advice regarding a particular subject. A rule of thumb is a general principle that provides practical instructions for accomplishing or approaching a certain task. Typically, rules of thumb develop as a result of practice and experience rather than scientific research or theory.

Investors may be familiar with a variety of "financial rules of thumb" that are intended to help individuals learn, remember and apply financial guidelines, including those that address methods and procedures for saving, investing and retirement. Although a rule of thumb may be appropriate for a wide audience, it may not apply universally to every individual and unique set of circumstances.

According to Wikipedia free encyclopedia “A rule of thumb is a principle with broad application that is not intended to be strictly accurate or reliable for every situation. It is an easily learned and easily applied procedure for approximately calculating or recalling some value, or for making some determination”. Compare this to heuristic, a similar concept used in mathematical discourse, psychology, and computer science, particularly in algorithm design.

The exact origin of the phrase is uncertain. The earliest citation comes from Durham’s Heaven upon Earth (Durham, 1685). "Many profess Christians are like to foolish builders, who build by guess, and by rule of thumb." (Durham, 1685). The phrase also exists in other languages, for example Swedish tumregel, Norwegian and Danish tommelfingerregel, sometimes in the variant "rule of fist", for example Finnish nyrkkisääntö, Estonian rusikareegel, German Faustregel, Hungarian ökölszabály or Dutch vuistregel, as well as in Turkish parmak hesabı (rule of finger) and in Persian "قاعدهسرانگشتی," which is translated as finger's tip rule. This suggests that it has some antiquity, and does not originate in specifically Germanic language culture” (Wikipedia, the free encyclopedia).

The term is thought to originate with carpenters who used the width of their thumbs (i.e., inches) rather than rulers for measuring things, cementing its modern use as an imprecise yet reliable and convenient standard. This sense of thumb as a unit of measure also appears in Dutch, in which the word for thumb, duim, also means inch (Williams et al., 2006).

Another possible origin of the phrase comes from measurement, in particular in agricultural fields. The plants need a fairly precise depth to seed properly, whether planted from seed or being replanted, but the depth can sometimes be estimated using the thumb. That is, a rule "(measurement) of thumb". According to Gary Martin, "The origin of the phrase remains unknown. It is likely that it refers to one of the numerous ways that thumbs have been used to estimate things—judging the alignment or distance of an object by holding the thumb in one's eye-line, the temperature of brews of beer, measurement of an inch from the joint to the nail to the tip, or across the thumb, etc. The phrase joins the whole nine yards as one that probably

derives from some form of measurement but which is unlikely ever to be definitively pinned down"(Wikipedia, the free encyclopedia).

Statistical - Rule of 72: A rule of thumb for exponential growth at a constant rate. An approximation of the doubling time formula used in population growth, according to which the doubling time is roughly equal to 70 divided by the percent growth rate (using continuous compounding, the actual number would be about 69.31 or 100 times the natural logarithm of 2). In terms of money, since most people use the annual effective interest rate (which is equivalent to annual compounding) for interest rates between 4% and 12%, the number that gives the most accurate result is actually 72. Therefore, one may divide 72 by the percent interest rate to determine the approximate amount of time it would take to double one's money in an investment. For example, at 8% interest, the investment will double in approximately 9 years (72/8 = 9).

Pork producers must determine when to sell pigs, which and how many pigs to sell, and to which packer(s) to sell them. We model the decision-making problem as a linear mixed-integer program that determines the marketing strategy that maximizes expected annual profit. By discretizing the barn population into appropriate weight and growth categories, we formulate a mixed-integer program that captures the effect of stocking space and shipping disruption on pig growth. We consider marketing to multiple packers via shipping policies reflecting operational sorting constraints. Utilizing data from Cargill Animal Nutrition, we implement the model to obtain solutions that characterize significant strategic departures from commonly-implemented industry rules-of-thumb and that possess the potential to increase profitability in an industry characterized by narrow profit margins.

4.4 The Structure – Conduct – Performance (SCP) Model

A large number of agricultural marketing studies rely on the theoretical foundations laid by the “perfect competition” model. This is particularly true in studies based on the structure-conduct-performance paradigm. The SCP paradigm originated from the work of Bain (1930). The SCP approach postulates that as market structure deviates from the paradigm of a perfect competition, the degree of competitive conduct will decline and there will be a consequent decrease in output (supply) and allocative efficiency, and an increase in prices. This implies that the performance of markets can be assessed based on the level of competition and efficiency in those markets (Williams et al., 2006).

The market conditions are influenced by the social, economic, technological, factor prices and tastes. These factors influence the method of analysis of markets among them the Structure, Conduct ad Performance (S-C-P) model, a standard tool for the analysis of markets. It is a framework for explaining how markets behave and the differences between them. This paradigm postulates that the market structure determines the market conduct, which then sets the performance of the market. It envisages that the number of sellers and buyers determines the behaviour of economic agents and thereby determine how close the industry comes to meeting the standard of reference of social welfare.

According to the structure-conduct-performance approach, an industry's performance (the success of an industry in producing benefits for the consumer) depends on the conduct of its firms, which then depends on the structure (factors that determine the competitiveness of the market). The structure of the industry then depends on basic conditions, such as technology and demand for a product. For example: in an industry with technology that the average cost of production falls as output increases, the industry tends to have one firm, or possibly a small number of firms. According to Barney (2007), the Structure-Conduct-Performance (S-C-P) paradigm of strategy assumes market structure would determine firm conduct which would determine performance. This is a paradigm that is foundational to industrial organization economics, consistent with the positional view of strategy, as opposed to the resource-based view of strategy.

To actually understand the meaning of structure conduct performance (s-c-p), we need to analyze the three major elements of the model namely: structure, conduct, and performance.

1. Structure: This refers to market structure. Market structure refers the organizational characteristics that establish interrelationships between the buyers and sellers of a particular market. Its elements include the number and size distribution of buyers and sellers, the degree of product differentiation, the ease of entry of new firms into an industry, vertical integration and cost structure. These characteristics influence the nature of competition and pricing within that market. The variables that are used to describe market structure include seller concentration, degree of product differentiation and barriers of entry. These variables can be further classified into two classes, namely:

(a) Intrinsic structural variables - those determined by the nature of products and available production and marketing technologies.

(b) Derived structural variables - those determined by firms and government such as barriers of entry, seller and buyer concentration and product differentiation (Schmalensee, 1989). This distinction may be important if intrinsic structural variables are exogenously determined, thus making them suitable candidates as instrumental variables.

2. Conduct: This refers to a firm's behavior. The market conduct is the pattern of commercial behavior that firms follow in adjusting to the markets in which they sell or buy. These commercial behaviors arise from the existing market structure and include price determination behavior, product behavior, research and development, innovation, advertising, sales promotion policies, financial policy and collusion and Conduct Elements.

The market structure determines the kinds of price determination strategies, advertising, product and price displays, sales promotion strategies, mode of payment/ terms of sales (deposit before delivery, cash terms and credit terms). The variables used to capture firm behavior include pricing strategies, collusion, advertising, research and development and capacity investment. Some have interpreted conduct as whether firms collude or compete.

3. Performance: This refers to outcome or equilibrium assessed in terms of allocative efficiency. The variables mostly used to measure performance are profitability and price-cost margin. This is the end result of which is essentially brought about the nature of market structure and how firms conduct themselves. It includes:

- The price relative to the average cost of production. A price that just covers the cost is ideal. This price assumes fair returns to the inputs used in production but allow no excess profits. This ideal would be reached under conditions of pure competition.
- The relative efficiency this far is influenced by the scale or size of the plant and firm relative to the most efficient and by extent, if any excess capacity. Efficiency can be viewed as operational efficiency, pricing efficiency and technical efficiency. Operational efficiency aims at cutting costs, pricing efficiency helps in the allocation of marketing resources and marketing efficiency is based on the input output ratio.
- The size of sales promotion costs relative to the costs of production. Are promotion costs excessively high? What percent are advertising costs of the total production?
- The character of the product, including the choice of design, level of quality and variety of product within any market. Is the quality of the product within the industry high? Is there any variety available to the consumer? Are products excessively improved to the extent buyers would prefer a lower quality at a lower cost?

- The growth rate of the firm and the industry in developing both products and techniques of production. Are firms attempting to find cost reducing techniques? One scope might be the scope of their research activity. Do firms try to discover what the consumer wants? Does the firm have a good public image?

The SCP paradigm posits specific causal relationships between market structure, conduct and performance. In particular, market structure determines conduct and conduct in turn determines performance.

Structure ➡ Conduct ➡ Performance

Limitation: The theory has been criticized on the following grounds: (1) its price integration and price performance analyses are static and suffers from spatial arbitrariness; (2) its market segmentation concepts with respect to margins and transfer costs are faulty; (3) it does not explain how competition among traders may affect consumers' welfare. Thus the approach fails to explain the causal links between structure, conduct and performance and is therefore unable to predict performance from structures and vice versa (Ajala, 2003).

Structural Parameters of the S-C-P Model

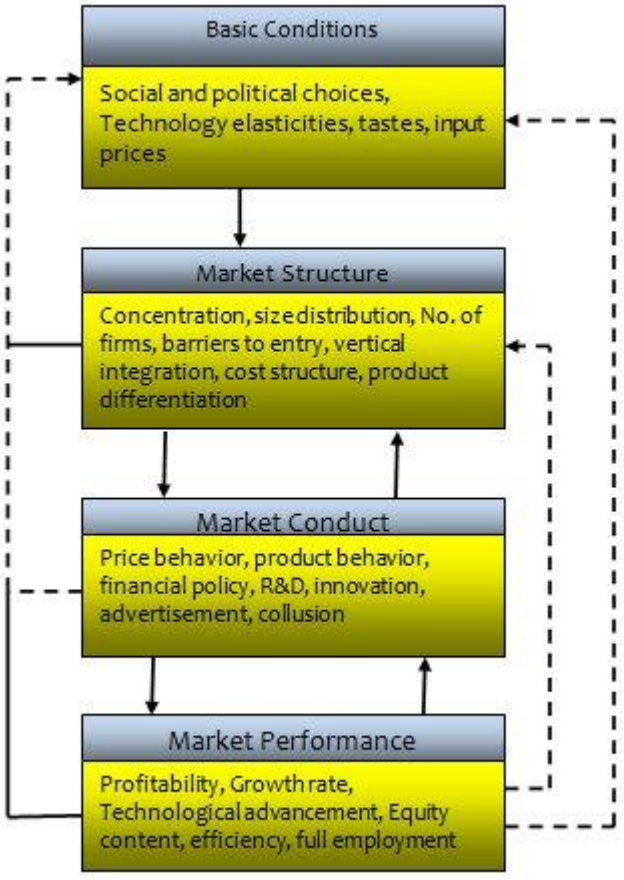


Fig. 4.2 Adapted from: CAEE 5131 - Agricultural Marketing and Price Analysis: Economic Role of Prices and Approaches to the study of Agricultural Market Organization and Performance, Moi University, Department of Economics and Agricultural Resource Management with support from OER Africa and Bill & Mellinda Gates Foundation (year).

Origin of Structure- Conduct- Performance (S-C-P)

In the 1930s, a group of economists began developing an approach for understanding the relationships among a firm's environment, its behavior, and performance. The original objective of this work was to describe conditions under which perfect-competition dynamics would not develop in an industry. Understanding when perfect- competition dynamics were not developing assisted government regulators in isolating those industries in which competition-enhancing regulations should be implemented.

The theoretical framework that developed out of this effort became known as the structure-conduct-performance model (SCP). The term structure in this model refers to industry structure, measured by such factors as the number of competitors in an industry, the heterogeneity of products, and the cost of entry and exit. Conduct refers to specific firm actions in an industry, including price taking, product differentiation, tacit collusion, and exploitation of market power. Performance in the S-C-P model has two meanings: the performance of individual firms and the performance of the economy as a whole.

The logic that links industry structure to conduct and performance is well known. Attributes of the industry structure within which a firm operates define the range of options and constraints facing a firm. In some industries, firms have very few options and face many constraints. Firms in these industries generate, at best, returns that just cover their cost of capital in the long run, and social welfare (as traditionally defined in economics) is maximized. In this setting, industry structure completely determines both firm conduct and long-run firm performance (normal).

In other less competitive industries, firms face fewer constraints and a greater range of conduct options. Some of these options may enable firms to obtain competitive advantages. Even when firms have more conduct options, industry structure still constrains the range of those options. Also, other attributes of industry structure- including barriers to entry-determine how long firms in an industry will be able to sustain their advantages. Without barriers to entry, any competitive advantages by firms in an industry will be quickly competed out away by new entrants. Thus, even in this case, industry structure still has an important effect on firm conduct

and firm performance even though firms in these industries can sometimes have competitive advantages.

Industries are perfectly competitive when there are large numbers of competing firms, products being sold are homogeneous with respect to cost and product attributes, and entry and exit are very low-cost. Examples of such perfectly competitive industries include the spot market for crude oil. As is well known, firms operating in perfectly competitive industries can act only as price takers. A firm is a price taker when it responds to changes in industry supply or demand by adjusting prices rather than attempting to influence the level of supply or demand. Price-taking firms can expect to gain only competitive parity.

The relationship between firm behavior and market structure has been a central focus of study in the field of industrial organization (IO). This emphasis is reflected in the manner in which some economists have defined IO, namely as the study of firm behavior in imperfectly competitive markets.1 Historically, the discipline's emphasis on firm behavior and market structure is, to a large extent, influenced by the work of a group of economists at Harvard in the 1930s. Edward Mason and his PhD student Joe S. Bain formulated a framework for empirical analysis called the Structure-Conduct-Performance (SCP) that attempted to describe how key aspects of market structure relate to each other.

The origin of the SCP paradigm can be traced to the work of the Harvard economist Edward Mason in the 1930s. The theoretical work of Mason's colleague Edward Chamberlin provided inspiration for both Mason and his student Joe Bain to study empirically how pricing and production policies of firms (especially large ones) are determined. Mason (1939) starting point was that market share is important in determining production and pricing policy of a firm. In the 1930s, there were generally two approaches in understanding pricing policies of firms, namely:

1. Theoretical approach - involving the use of oligopoly and monopolistic models to derive production and pricing policy of a firm.
2. Empirical approach - involving the correlation between observed prices and other economic variables representing differences in market structure

Mason argued that empirical analysis is essential to ensure that the theories of firm are useful. This is because theories are based on mathematical constructs such as demand and cost functions which are not ascertainable (in Mason's words, p.64). Thus, it is not that theories are

not important, rather their relevance cannot be determined without empirical observations. This leads to the question of the set of empirical observations that are useful.

Interestingly, Mason argued that the price and production decisions of a firm are influenced by both the internal organization of the firm as well as market structure. Internal organization here refers to group relationships within the firm which exerts influence on the firm's policy. According to Mason, market structure is a multidimensional concept that is specified and measured by variables such as product characteristics, cost and production characteristics, and the number and market shares of buyers and sellers in the market. There are also other factors that influence firm behavior such as industry life-cycle and the characteristic of the distribution channels.

4.5 Commodity Chain Model

A commodity chain is a series of interlinked exchanges through which a commodity and its constituents pass: extraction or harvesting, production, transformation, transport, distribution, wholesale, retail and end use. As such, commodity chains serve as conduits through which commercialized natural resources—such as forest products—are ushered from the land to their final users, whether rural, urban or 'international' (Ribot, 2005). A commodity chain could also be seen as a process used by firms to gather resources, transform them into goods or commodities, and finally, distribute them to consumers. It is a series of links connecting the many places of production and distribution and resulting in a commodity that is then exchanged on the world market. In short, it is the connected path from which a good travel from producers to consumers. Commodity chains can be unique depending on the product types or the types of markets. Different stages of a commodity chain can also involve different economic sectors or be handled by the same business.

Commodity-chain analysis is a method for analyzing how and for whom such market conduits operate. It is a tool for understanding that benefits from natural resources, how they benefit, and how those patterns of benefit distribution might be changed. According to Rodrigue (2013), Commodity chain analysis is the identification of the actors and processes that contribute to the origination of a product that is consumed by a market, such as raw materials, food or consumption goods. Thus, a commodity chain includes a sequence of operations ranging from the extraction of raw materials, the assembly of intermediate goods, to the distribution to consumption markets. Commodity chain analysis can also consider only a specific segment related to a single product (or group of products).

The analysis of such a complex chain of agents and processes considers several perspectives:

- Transactional perspective: Identification of the flows and of the transactions that create them. This particularly concerns the decision-making process in the establishment and management of commodity chains.
- Comparative perspective: Assess the relative competitiveness of the elements of the commodity chains in terms of added value.
- Functional perspective: Identify the physical processes involved in the circulation of goods, including the capacity constraints in distribution, namely modal, intermodal and terminal effectiveness.

The analysis of commodity chains, depending on the perspective, can consider several factors:

- Origin and destination. This is a basic issue of supply and demand which reveals comparative advantages, locational preferences and market size. A commodity chain is commonly organized as a sequence of origin / destination pairs until a destination is considered to be the location of final consumption. For complex products, a multitude of origins, intermediary stages and destinations imply the concept of global commodity chains, Intermediary locations where activities such as warehousing need also to be considered.
- Cost function. Evaluates the costs incurred to the set of activities taking place along the commodity chain such as procurement costs, manufacturing costs, distribution costs and retailing costs.
- Load unit. Considers how the material flows in the commodity chain are circulating, often related to how fragile, perishable (see the Cold Chain) or valuable a product is. It is more than simply an issue of containerization, but also in which way the containerized load unit is used.
- Modal and intermodal use. A matter of the nature of the transport chains used to accommodate the commodity chains in terms of modes, terminals and freight forwarders.
- Regulation and ownership. The set of rules and regulations related to the circulation of goods within the commodity chain, including compliance. Also considers the nature and the level of control shipping companies have over the commodity chains they use through agreements, mergers and alliances.

- Distribution channel. This involves the relationships with logistical service providers, particularly with manufacturers and retailers. In many cases, distribution activities are subcontracted.
- Added value. This is the consideration of which parts of the commodity chain contributes the most to added value. This is an important strategic goal as added value is linked with profit margins. The organization of commodity chain thus seeks to increase added value through locational and organizational strategies.

Bernstein and Amin (1995) outlined the distinctive features of commodity-chain analyses. First is an empirical, as well as theoretical focus on markets, in lieu of formal abstract neoclassical economic modeling (also see Bohannan & Dalton, 1965; Harriss, 1984; Plattner, 1985; Alexander, 1987; Alexander 1993; Mackintosh, 1990; Ribot, 1990; Ensminger, 1992; Hewitt de Alcantara, 1993; Dilley, 1993; Bernstein 1996). Second is attention to power: its sources, uses and effects in a socially differentiated environment. Third is an approach to politics and political institutions as endogenous to the existence and functioning of markets, with attention to differentiated market agents engaging in competitive as well as collective or collusive action.

Fourth, and last, is the view that regulation (by which they mean both state and non-state forms of control) too is an endogenous feature of markets, hence shifting debates from their current focus on 'more vs. less' regulation to the study of 'better vs. worse' forms of regulation. This method of analysis also broadens predominant focus on individual mechanisms of control and accumulation—such as prices or property—to include in the analysis of markets the whole repertoire of interacting mechanisms shaping their operation (Ribot, 1998). Further, production and exchange are seen as embedded within social relations and hierarchies (Gereffi, Korzeniewicz & Korzeniewicz, 1994; Granovetter, 1985; Platteau, 1996). production and exchange are also characterized in a multi-local manner, spanning the geographic extent of production, distribution, exchange and use.

The term Commodity Chain is used to refer to the overall group of economic agents (or the relevant activities of those agents) who contribute directly to the determination of a final product. Thus, the chain encompasses the complete sequence of operations which, starting from the raw material, or an intermediate product, finishes downstream, after several stages of transformation or increases in value, at one or several final products at the level of the consumer. More precisely, it is used to mean the group of agents (or part thereof) who

contribute directly to the production, then to the transformation and delivery to final market of a single agriculture or livestock product.

Different methodologies have been developed for analysis of commodity chains. Commodity Chain Analysis according to Tallec and Bockel (2006) in what they called “l’approche filière”, is a value-free technique applied to analyzing existing marketing chains for agricultural commodities assessing how public policies, investments and institutions affect local production systems. It consists of quantitative analysis of inputs and outputs, prices and value added along a commodity chain through accounts by agent. The dominant idea behind the economic analysis of commodity chains is to lay out the overall activities of all the participants, or agents, who contribute to the production and/or transformation of a given commodity. This process involves:

(a) identifying the outline of the chain and the position of the various agents within it,

(b) developing the economic accounts corresponding to the activities of the agents involved in the chain.

This reduction of activities and operations to their monetary value makes this economic technique a powerful tool of analysis. It allows using commodity chain analysis to produce properly quantified and significant results, calculations at new levels of aggregation, sensitivity and simulation analyses, and to interpret these results at the macroeconomic level.
The commodity chain model builds on the SCP framework. It assumes vertical as well as horizontal relationships between livestock producers in evaluating market performance and is more dynamic in following the entire commodity flow from producer to the ultimate consumer. At each stage along the commodity chain, the model permits three types of analysis namely: (i) costs and margins, (ii) spatial flows (involving places, volumes and directions), and (iii) the social relations of trade (Klober et al., 2001; Kong et al., 2009).

Limitation: This phenomenon increases transaction costs and, consequently, increases the amount paid by the final consumers (sales price). For instance, a more distant market may be influenced by the desire to avoid transactions costs. On the other hand, the same pig farmer may decide to go all the way to a distant market because of excessive profits made by intermediary traders – a situation, which lowers return to producers.

4.6 Transaction Cost Model

Transaction costs theory represents one of the first attempts to develop a comprehensive theory that considers the structure of the firm as a source of explanation for outcomes, in contrast to viewing the firm as a 'black box' that has little influence in explaining such outcomes. Transaction cost is the cost incurred in making an economic exchange or the cost of participating in a market. There are three categories that transaction cost can be divided into, namely:

(a) Search and information costs- These are those costs incurred in determining that the required good is available on the market, which has the lowest price and good quality

(b) Bargaining costs- These are cost required to come to an acceptable agreement with the other party to the transaction, drawing up an appropriate contract.

(c) Policing and enforcement costs- These are the cost of making sure that the other party sticks to the term of the contract and taking appropriate action if the contract is broken.

Let's use an example of a swine buyer/consumer. The swine buyer faces a variety of different transaction costs. The search costs are the cost of finding a good farm with a healthy swine. The bargaining costs are the costs of negotiating the price with the farmer. While the policing and enforcement costs are the costs of ensuring that the swine is delivered in a good condition.
The model shows institutions and market as a possible form of organization to coordinate economic transactions. If the external transaction costs are higher than the internal transaction cost, it is expected that the firm will grow, whereas, if the internal transaction costs are higher than the external transaction cost, the firm will be downsized by outsourcing.

The term transaction cost is mostly thought to have been coined by Ronald Coase, who used it to develop a theoretical framework for predicting when certain economic tasks would be performed by firms, and when they would be performed on the market. However, the term transaction costs can be traced back to the monetary economic literature of the 1950s, and does not appear to have been consciously coined by any particular person (Robert Kissell & Morton Glantz, 2003).

Oliver E. Williamson's transaction cost economics popularize the transaction cost model. Today, transaction cost economics is used to explain a number of different behaviors. This often involves considering as transactions not only the known cases of buying and selling but also day-

to- day emotional interactions, informal gift exchanges etc. According to Williamson, the transaction costs are determined by frequency, specificity, uncertainty, limited rationality, and opportunistic behavior.

Two definitions of the phrase transaction costs are commonly used in literature. The one by Steven N. S. Cheung which says that transaction cost is any cost that arise due to existence of institutions. For Cheung, if the term transaction costs were not already so popular in economics literatures, they should more properly be called institutional costs (Steven, 1987; Werin & Wijkander, 1992). But many economists seem to restrict the definition to exclude costs internal to an organization (Harold, 2003). The latter definition parallels Coase's early analysis of costs of the price mechanism and the origins of the term as a market trading fee.

Transaction cost theory tries to explain why companies exist, and why companies expand or source out activities to the external environment. The transaction cost theory supposes that companies try to minimize the costs of exchanging resources with the externalities, and that firms try to minimize the bureaucratic costs of exchanges within the firm. Firms are therefore weighing the costs of exchanging resources with the environment, against the bureaucratic costs of performing activities in-house.

The theory sees institutions and market as different possible forms of organizing and coordinating economic transactions. When external transaction costs are higher than the company's internal bureaucratic costs, the company will grow, because the company is able to perform its activities more cheaply, than if the activities were performed in the market. However, if the bureaucratic costs for coordinating the activity are higher than the external transaction costs, the company will be downsized.

According to Ronald Coase (1937; Kong et al., 2009), every company will expand as long as the company's activities can be performed cheaper within the company, than by e.g. outsourcing the activities to external providers in the market.

According to Williamson (1981), a transaction cost occurs "when a good or a service is transferred across a technologically separable interface". Therefore, transaction costs arise every time a product or service is being transferred from one stage to another, where new sets of technological capabilities are needed to make the product or service.

The transaction costs related to the exchange of resources with the external environment could be reflected by the following factors:

- Environmental Uncertainty
- Opportunism
- Risks
- Bounded Rationality
- Core company assets

The factors above will all potentially increase the external transaction costs, where it may become rather expensive for a firm to control these factors. Therefore, it may very well be more economical to maintain the activity in-house, so that the company will not use resources on e.g. contracts with suppliers, meetings, supervision etc.

Therefore, if firms see the environmental uncertainty as high, they might choose to not outsource or exchange resources with the environment. Let's take for example; if a firm is thinking about outsourcing its production of a given product, it may assess the costs related to such a transaction with the environment. If the firm sees it as difficult to formulate a contract that controls the uncertainties related to the exchange, the firm may regard it as too costly to outsource the production. This is because the transaction costs of monitoring the exchange are perceived to be higher, than the bureaucratic costs of performing the activity in-house.

Managers must therefore weigh the internal transaction costs against the external transaction costs, before the company decides whether or not to keep some activity in-house, or to e.g. outsource the activity to the environment.

This model presumes that traders in each market have perfect knowledge of the situations in all other markets and, as such, inter-market price differentials only reflect transportation and handling costs between concerned markets. Transactions costs include inter alia, the costs of searching for a partner with whom to exchange, bargaining with potential trading partners to reach an agreement, transferring the product (typically involving transportation, processing, packaging and security title if necessary), and enforcing (or seeking damages for violation of the exchange agreement) (Halasa et al., 2004). The transaction costs model predicts that transactions costs increase with distance, market concentration, systemic complexity and

declining clarity of property rights and that transactions costs decline with relational contracts, with standardizing quality and quantity.

Limitation: The smallholder nature of swine production in South Africa has implications for increasing marketing cost because more intermediaries are involved between these smallholder producers (who are widely dispersed in space) and the consumers who are located several kilometers away. In addition, the volumes of swine handled by these farmers are small, requiring market agents to move round these farmers to collect the few pigs that are to be sold. It is expected that if transactions costs are lowered, there would be an increased traded volume with economic benefits to both traders and swine producers while the increased volume of livestock trade will promote regional trade and integration.

4.7 Stochastic Model for Swine Marketing

A stochastic model is a tool for estimating probability distributions of potential outcomes by allowing for random variation in one or more inputs over time. The random variation is usually based on fluctuations observed in historical data for a selected period using standard time - series techniques. Distributions of potential outcomes are derived from a large number of simulations (ie. Stochastic projections) which reflect the random variation in the input(s).

Pork processors have the objective to produce uniformly sized lean products. Most pork processors have developed marketing systems to discount carcasses with weights less or greater than the desired optimal range. Swine producers must evaluate alternative marketing strategies that reduce sort loss. Researchers have sought for a way to assist swine producers to maximize their profit by employing the stochastic model in various aspect of swine production.

Among the various stochastic models employed for swine farmers, two will be considered in this chapter namely:

1. Use of stochastic model to evaluate alternate marketing strategies
2. Using a stochastic model to evaluate swine production management with paylean: split – weight management.

4.7.1 Use of Stochastic Model to evaluate alternate marketing strategies

The research on the use of stochastic model to evaluate alternative marketing strategies was carried out by Schinckel (2002) at Purdue University Indiana U.S.A. In this research four alternative marketing strategies were evaluated as to their impact to reduce variation for

carcass component mass and carcass measurements. The following assumption that the objective of the producer was to market swine with an average fat-free lean mass close to 102.1 lb. was made. For multiple day marketing, a sort weight was pre-defined. Any swine with a live weight exceeding that sort weight was marketed. The only exception was on the final marketing day, when all residual swine were marketed. The target sort weight for each multi-day marketing strategy was found by setting the sort weights at 242, 248 and 254 lb and predicting the mean fat-free lean mass at these weights.

The first marketing strategy was to market all swine at 160 d of age. The second strategy was to market all swine above 250.9 lb body weight at 146 d (21.2%; mean = 261.5 lb) and 160 d of age (53.5%; mean = 264.3 lb), and all remaining pigs at 174 d of age (25.3%; mean = 262 lb). The third strategy was to market swine above 247.6 lb at 146 d (25.8%; mean = 259.3 lb) and 160 d (53.0%; mean = 262.2 lb) of age, and all remaining pigs at 181 d of age (21.2%; mean = 270.4 lb). The fourth strategy resulted in swine above 256.6 lb marketed on a weekly basis (12.0, 21.9, 28.8, 19.6, and 9.6%; with mean body weights of 266.6, 264.2, 263.7, 264.7, and 264.6 lbs at 146, 153, 160, 167, and 174 d of age) and the remaining pigs (7.1%; mean = 250.7 lbs) marketed at 181 d of age.

Using the stochastic model, the researchers concluded that the best compromise for pork producers is to carefully sort swine three times from a facility with swine of the same sex. The stochastic model can be used to evaluate alternative marketing strategies that compromise between the pork producer's labor and transportation costs and the pork processors' reduced returns associated with excessive ariation in carcass weight and composition.

4.7.2 Using a Stochastic Model to evaluate Sswine production management with Paylean: Split – Weight Management

The second stochastic model under consideration was carried out by N. Li et al (2003) at Purdue University Indiana, U. S. A. The concept of split-weight feeding management for swine production has existed for a long time. However, because of the high cost of separating pigs by hand, and the labor involved, split-weight management is not widely adopted by swine producers. With the introduction of the Automatic Sorting Technology (known as AST) into the hog industry, split-weight management is made easier and cheaper to accomplish once the AST barn is invested. To help producers implementing split-weight management, it is necessary to evaluate the benefit of split-weight feeding and to investigate the optimal dietary nutrition management for different weight groups of swine.

Assumptions: The model assumed swine were split by weight into two groups when swine were 100 days of age: a heavier group versus lighter group, at the late finishing stage when they average 146 lbs. The model also assumed that Paylean (ractopamine, RAC) was used in the swine production and it could be fed at different concentrations and durations for each group. Different dietary lysine concentrations were allowed to be fed with Paylean.

Furthermore, the model assumed that three diets were fed to each split weight group, one diet before Paylean onset and two diets containing Paylean. The same dietary lysine concentration was fed to both groups before Paylean. It was also assumed that diet 2 must be fed for exactly 2 weeks, and then switched to the diet 3.

The optimal management was derived for four payment schemes: (1) carcass payment with discounts on underweight and overweight carcasses; (2) carcass merit payment system adopted from Hormel's Carcass Lean Value Program; (3) lean to fat price ratio of 2:1, with discounts on underweight and overweight carcasses; and (4) lean to fat price ratio of 4:1, with discounts on underweight and overweight carcasses. The carcass weight discount grid for payment schemes 1, 3 and 4 were also adopted from Hormel's Carcass Lean Value Program, which was the standardized grid for 0.51-0.90-inch last rib backfat. Payment schemes 1 and 2 reflected the marketing approaches by independent producers. Payment scheme 3 simulated the producers under limited coordination with packers, while payment scheme 4 reflected vertically integrated producers, because the lean-to fat ratio of 4:1 allowed producer to capture the full benefit of the increase in carcass value.

The barn size of 1,000 head was used; thus, each weight group consisted of 500 head. Swine were marketed together regardless of weight groups. It was assumed that as long as the number of swine heavier than the sort weight exceeded 170 head, the heaviest 170 pigs were marketed on a semi-truck. For a group size of 1,000 head, six truckloads were needed to market all the swine. To sum up, the model optimized 14 variables: two Paylean concentrations, two optimal Paylean onset ages, two dietary lysine concentrations for diet 2, two dietary lysine concentration for diet 3, and six marketing days.

The model results showed that split-weight management for swine production with Paylean did not increase the returns to a large degree. Although the lighter half of swine were optimally fed with a higher Paylean and dietary lysine concentrations, the optimal marketing ages would be

the same as for the non-split-weight management. Because producers usually market their swine to a targeted weight range, the growth rate of the lighter swine has to be increased to speed up the barn turnover, and thus increase the production return. The predicted return from the model simulation would be helpful for producers to assess if split-weight management was economically optimal to implement.

4.8 Spreadsheet marketing Model

A model is a purposeful representation of a real situation, designed to address a particular situation. We use mental models every day to make many decisions. Visual and physical models help people to better understand a situation. Mathematical models comprise a set of relationships linking inputs to outputs. Mathematical models are often implemented using spreadsheets.

Spreadsheet modeling is a document built especially for any purposes and many industry-like financial services, customer services etc. The spreadsheet modeling process consists of understanding the problem, planning the spreadsheet on paper, developing the base-case model, testing the model, using the model for analysis, and documenting the model. Scenario and sensitivity analysis are useful tools used to gain more insight into the problem. Spreadsheet models should be correct, flexible, and documented. A spreadsheet model should produce the correct answer for the information given.

A spreadsheet model must be flexible in producing accurate results even if the user changes any of the inputs (controllable or uncontrollable). To provide this flexibility, users should enter each input only once in the model. For example, consider a model that includes a unit cost as an input. This value, let's say R3.50, would be entered into a single cell, for instance, B8. Any other cells using unit cost in their calculations would then reference cell B8 rather than having the R3.50 value "hard-coded" inside its formula. In this way, the user only needs to change the data item in a single cell to analyze a new problem. Flexibility is often ignored by people developing a spreadsheet they think will only be used once. Most models in the real world are used repeatedly, with different input data. Even if you think yours is a model that will be used only once, your model will be easier to explain to others if every input is shown explicitly and only once. It is vital to get into the habit of building flexible models from the start.

There are basic steps to follow in order to develop an effective spreadsheet model. These include:

1. To turn off the computer, and instead draw a picture to better understand the situation. Then identify the uncontrollable inputs, the decision variables, and the outputs. Define the logic necessary to transform the inputs into the outputs.
2. Sketch out an overall plan for the model on paper. In general, group the inputs together. Determine where the inputs, intermediate calculations, and outputs will go. Plan to highlight the key inputs and outputs to make the model easier to use for what-if analysis. Determine the formulas relating the inputs to the intermediate calculations and outputs. This can be very simple for some models (i.e., Profit revenue expenses), or it may be quite complicated. In general, the time spent planning a model in this step is normally much less than the time spent debugging an unplanned, completed model.
3. Develop the base case spreadsheet model. Group the inputs together logically. It usually helps to use a color-coding scheme so the user can quickly determine what are the inputs and outputs of the model. Break down the intermediate calculations so that each formula is relatively simple. You can then more easily spot and correct errors. Research has shown that most spreadsheet-model developers believe their products to be error-free, but this assessment is usually wrong! Thus, you need to scrutinize formulas and results during and after the spreadsheet development effort. Use specific text labels, including units of measure, so that others reading the model can follow your thought process. The outputs should also be clearly labeled and color-coded. For large models (loosely speaking, those that do not fit in a window screen), it is often very helpful to provide a summary of the outputs next to the inputs.
4. Test the spreadsheet model using trial values. Verify the results by hand, if possible. If you have broken down the intermediate calculations into relatively simple formulas, this step is much easier.
5. Use the model to perform the needed analysis. This may involve a relatively simple calculation, preparation of a chart, or more substantial analysis. Two common types of analysis are scenario analysis and sensitivity analysis. A scenario is a specific set of conditions that could occur in a real situation. A common practice is to look at the base-case, best-case, and worst-case scenarios. Scenario analysis helps a decision manager gain additional insight into a situation. Sensitivity analysis involves studying the changes to the output of the model (e.g. profit) as one or more of the inputs (e.g., demand) change. Sensitivity analysis helps to identify the inputs that cause the most change in the output.
6. Document the model so that others can easily understand it. Remember, others may not think of the problem in exactly the way you do, so descriptive labels and a logical

layout are extremely important. Indeed, ideal spreadsheet models are almost "self-documenting" as a result of the way you organize and label them. Cell comments can also be used to document and explain key formulas.

The purpose of any model is the understandability of it for anyone to apply. Therefore, a spreadsheet model should be well documented. The following guidelines are necessary. They include:

- descriptive text labels for all numerical inputs and calculations. Include in the label the units of measure of the quantity (e.g., money, hours, kg, meter square).
- the use of numerical formatting (Format/Cells/Number) to display the numerical information in the model. The most common useful formats are number (fixed number of decimal places), currency, and percentage. Others are also useful in certain situations (e.g., date, time, custom formats).
- applying appropriate cell formatting, such as fill colors, font colors, text attributes (e.g., bold, italic), and cell borders. As noted, color-code the inputs and the outputs of the model. A judicious use of coloring can make certain items in a model stand out for the user.
- inserting a cell comments for key cells. To use Excel's Comment feature, right-click any cell. From the submenu, click Insert Comment. You can type anything you want into the box that pops up. This box will remain "attached" to the cell and can even be printed with the model. Use comments to add explanatory information about a calculation or assumption that does not have to be in the model itself.

They can help furnish information on the logic behind a calculation or the justification for a particular value of an input. In many of the spreadsheet examples in this supplement, we used the Cell Comment feature to show the formula in a cell.

- Print a copy of the spreadsheet with row, column headings, gridlines and footer. Also, print a copy of the spreadsheet formulas. Ideally, a spreadsheet model should be self-documenting. That is, there should be little work involved in documenting a spreadsheet model if you adopt a logical structure for the data and calculations, add descriptive labels that include the units of measure, use numerical and cell formatting appropriately, and provide additional comments to highlight or explain key, or possibly more difficult, aspects of the model.

The SP-MM will demonstrate relationships beyond basic production costs. This proposition is derived from the fact that variation in weight gain drives variation in market weight and revenue. Mean weight and variation of weight, combined with the pricing matrix, drives revenue. User inputs may include costs, performance (feed conversion rate (FCR), mortality, ADG and its variability), and pricing matrix. The model will calculate economic efficiency measures, and will contrast results for fixed time (DATE) and target market weight (WEIGHT) production systems.

Advantages: The overall advantage of the SP-MM includes estimation of production improvements necessary to cover contingencies, such as changes in market prices, demand and supply terrain, health intervention and sundry costs.

CHAPTER 5

RESEARCH METHODOLOGY

5.1 Introduction

In the preceding chapters, the researchers discussed extensively the review of the relevant literature of the subject, examined critically the various actors on swine marketing and swine production processes. They also considered the best management practices (BMPs) in swine production methods. Marketing models that were used by various researchers was also considered. In this chapter, the researchers intend to unveil the processes and methods that will be used in carrying out the research. Research methodology is a set of chronologically ordered activities prescribed for the conduct of research (Avowokeni, 2006). The Methodology is the general research strategy that outlines the way in which a research project is to be undertaken and, among other things, identifies the methods to be used in it. These Methods, described in the methodology, define the means or modes of data collection or, sometimes, how a specific result is to be calculated (Howell, K. E. 2013) Research comprises defining and redefining the problems, formulating hypotheses and suggested solutions, collecting, organizing, and evaluating data, making deductions and reaching conclusions. Research methodology is a way to systematically solve the research problem.

This chapter comprises of conceptualization of the study, problem statement, explanation of the problem statement, research questions and objectives, and research hypotheses. Also, to be considered in this includes: research instrument, testing the validity and reliability, sample size and method of determination of it, data processing, and the summary.

5.2 Motivation of the Study

The traditional approach to examining cattle feeding profitability focuses on allocating net returns into two components: (1) gain per head attributable to price changes from the time the feeder was purchased until it was sold, and (2) the returns associated with the increase in weight times the difference between the sale price per pound and feed cost per pound of gain (Heady & Jensen, 1954, Lambert & Sands, 1984). Swanson (1959) demonstrated that this typical division of returns to cattle feeding was based on an arbitrary accounting convention and could not be supported by the theory of the firm.

Swanson and West (1963) noted that allocating returns to the feeder animal's price margin and the feeding margin gives the erroneous impression that the level of net returns to cattle feeding can be completely explained by these two factors. They proposed using coefficients of separate determination (Wright) to statistically estimate the relative importance of the buying and selling operation versus the feeding operation. Using Illinois Farm Bureau Farm Management Service records, they were able to explain 82 percent of the variation in net cattle feeding returns with 38 percent attributable to the price margin and 44 percent explained by the feed cost per pound of gain.

In a related study focusing on the swine industry, Edwards et al. (1989) studied the relative importance of facility, feed, labor, operating, and health costs, sale prices, and reproductive performance on the profitability of farrow-to-finish swine operations in Iowa. They concluded that feed and facility costs were critical factors affecting variability in profits across producers. The high degree of aggregation present in most existing studies means that little or no information is available regarding the specific effect of factors such as Stocking Rate, Distance to Market/Abattoir and Transportation Cost, Production Cost, Access to Government Agricultural Subsidy, Access to Bank Loan, and Membership to Swine organisations measures on profitability. The relative impact of various factors affecting profitability is an important ingredient in the development of Swine marketing models/strategies. Considering the fact that the Swine producers in the Free State especially the rural farmers lack knowledge of the factors mentioned above, this research will assist the farmers to maximize their profit. The study will come up with a Marketing Model/Strategies that will boost the profitability of Swine producers in the Province and the country at large.

5.3 Problem Statement

A problem statement is a clear concise description of the issue(s) that need(s) to be addressed by a problem-solving team. It is used to center and focus the team at the beginning, keeps the team on track during the effort, and is used to validate that the effort delivered an outcome that solves the problem statement.

There is no documented Marketing Model available to assist the Free State swine producers maximize profits at least not the one the researcher is aware of. The traditional marketing system for swine by the Free State swine producers is characterized by independent producers and open market bargain. Most of the swine producers rely solely on prices negotiated in cash markets to establish base pork price. However, declining trade in cash pork markets makes

using these markets as a base problematic. In particular, concerns regarding how representative cash prices are of market conditions make their future use questionable. The extent to which this assertion is true for swine marketing in the Free State is uncertain, for the state of knowledge on livestock marketing largely comes from studies on cattle (Schonfeld, 2001), poultry (Ohlmann & Jones, 2008), sheep and goat (Dahlhoff, 2002).

5.4 Problem Description

Swine producers typically market their pigs to several distributors, and a lack of uniformity in measuring and reporting carcass data exists among swine industries (Schonfeld, 2001). Because of this inconsistency, producers find it difficult, if not impossible, to compare their market hogs with pigs from other operations. Moreover, most of the farmers do not have the knowledge of the best marketing channel to use in other to maximize their profit. Producers also have difficulty understanding and comparing carcass data from their own pigs sent to different abattoirs. Efforts have been made to help the farmers to reduce the production cost, distance to the abattoir and the stocking rate so as to boost the gross income of the farmers. Thus, there is an urgent need of developing an effective Marketing Model/channel for optimization of profit margin by the pork producers.

5.5 Objectives of the Study

Primary objective

- The primary objective is to develop a Marketing Model to assist Free State swine producers to maximize profit.

5.5.1 Secondary objectives

The secondary objectives are to:

- To Formulate the stocking rate to be adopted by swine producers in Free State
- To determine the effect of distance to the market/abattoir on transportation cost.
- To determine to what extent Production cost, affect Gross income of Swine Producers in Free State
- To determine to what extent does government agricultural policy affect Gross income of swine producers in Free State
- To determine the extent does access to bank loan affect Gross income of Swine Producers in Free
- To find out how membership of swine organisation affect Gross income of Swine Producers in Free State

5.6 The Research Questions

The research questions that need to be answered in this study include:

- What marketing model/channels should be adopted by swine producers in Free State
- To what extent does the stocking rate adopted affect swine producers in Free State
- To what extent does distance to the market/abattoir affect transportation cost
- To what extent does Production cost affect Gross income of Swine Producers in Free State
- Does government agricultural policy affect Gross income of swine producers in Free State
- To what extent does access to bank loan affect Gross income of Swine Producers in Free State
- Does membership of swine organisation affect Gross income of Swine Producers in Free State

5.7 Research Hypotheses

A hypothesis is an educated prediction that provides an explanation for an observed event. An observed event is a measurable result or condition. If you can't measure it, then you can't form a hypothesis about it because you can't confirm or reject it. In addition, a hypothesis typically takes the form of an if-then statement so you can test it with your research. In this research the null hypothesis will be used. A null hypothesis as seen by (Paul J. Lavrakas, 2008) is one in which no difference (or no effect) between two or more variables is anticipated by the researchers. This follows from the tenets of science in which empirical evidence must be found to disprove the null hypothesis before one can claim support for an alternative hypothesis that states there is in fact some reliable difference (or effect) in whatever is being studied. The null hypothesis is typically stated in words to the effect that "A equals B." The concept of the null hypothesis is a central part of formal hypothesis testing.

The following null hypothesis will be considered:

HO1 There is no significant difference in the marketing channels adopted by swine producers in Free State.

HO2 There is no significant difference in the stocking rate adopted by swine producers in Free State.

HO3 here is no significant relationship between distance to market/abattoir and transport cost.

Ho4 Production cost does not significantly affect Gross income of Swine Producers in Free State

Ho5 Access to government agricultural subsidy does not significantly affect Gross income of producers in Free State

Ho6 Access to bank loan does not significantly affect Gross income of Swine Producers in Free State

Ho7 Membership of swine organisation does not significantly affect Gross income of Swine Producers in Free State

5.8 Research Design

Research design means the methods and procedures for conduction the particular study. It is a purposeful scheme of action proposed to be carried out in a sequence during the process of research focusing on the problem under consideration. Though collection and analysis of data make an important aspect of the research and hence the research design, there are many other aspects to be included in it. In words of Claire Selltiz, research design should be such that it leads into logical conclusions. On the basis of methodology, research design can be classified under three titles:

(i) Experimental Research Design

(ii) Exploratory Research Design

(iii) Diagnostic or Descriptive Research Design

Burns and Groove (2001) defined exploratory research as research conducted to gain new insights, discover new ideas, and for increasing knowledge of the phenomenon. As noted by Singh, K. (2007) “exploratory research is the initial research, which forms the basis of more conclusive research. It can even help in determining the research design, sampling methodology and data collection method” Exploratory research “tends to tackle new problems on which little or no previous research has been done” (Brown, 2006). The study attempts to explore the experiences of Swine farmers who have been in the past five years and above in selected districts of Free State Province that are predominantly swine farmers in South Africa.

In this research exploratory research is employed as the problem not clearly defined. Exploratory research will help the researcher to gather any preliminary information that will help define problem and suggest hypotheses. Exploratory personal investigations involve original field interviews with the household members. It helps the researcher to have a greater insight into all possible practical aspects of the research problem. Pilot surveys of the initial

ideas helped to refine the final statements of the scale. The survey of the concerning literature has been very helpful in formulation of the research problem.

The study will be conducted using both qualitative and quantitative non-experimental research approaches.

Qualitative study: A qualitative study will be designed to provide detailed empirical evidence about the existing marketing trends and practice by the swine producers in the Free State Province of South Africa. The individual swine producers from both commercial and small-holder units were selected to be as representative of the swine industry as possible. This component of the research was conducted by means of a semi-structured, open-ended questionnaire using the procedures of McMillan and Schumacher (2001).

The qualitative study concentrated on establishing current view among swine producers in the Free State Province towards the industry practice for managing pigs to marketing age, changing nature of marketing activity, marketing channels, marketing strategies, marketing prices, profit maximization and marketing barriers. These qualitative data will afford alternative perspectives on some of the key issues that will be investigated through quantitative non-experimental analysis, particularly the different meanings attached to the concept of swine marketing strategies for maximization of profit. They will also enable evidence-based evaluation of industry and individual swine producers approaches to the marketing strategies and practice in the Free State Province. The swine producers were selected to reflect differences across the swine producers in terms of marketing intensity, swine management type, size and specialization, individual and industry interactions.

5.9 Population of the Study

A research population is generally a large collection of individuals or objects that is the main focus of a scientific query. It is for the benefit of the population that researches are done. However, due to the large sizes of populations, researchers often cannot test every individual in the population because it is too expensive and time-consuming. A research population is also known as a well-defined collection of individuals or objects known to have similar characteristics. All individuals or objects within a certain population usually have a common, binding characteristic or trait (Explorable.com, Nov 15, 2009). In this study, the population consists of 1304 swine producers within the Free State province of South Africa. Three local municipalities were chosen for the study based on their large production of pig. The local

municipalities chosen includes: Maluti a Phofung with 215 pig farmers; Mangaung with 138 pig farmers; and Moghaka with 116 pig farmers (data collected from department of agriculture Free State). The estimated total number of pig farmers in the selected Local Municipalities is 469. Accessible population of 100 pig farmers was selected for the study. These are farmers who have been in the business for the past 5-15 years. The study was conducted in Bloemfontein/Botshabelo, Kroonstad, Thaba Nchu and Qwa-Qwa. These experimental sites were chosen because of the preponderance of swine farms in the localities. Moreover, most of the swine producers are concentrated in the experimental sites selected.

5.10 Sample Size and Sampling Techniques

A sample size 80 swine producers was determined by using Tara Yamani sample size determination technique. For this study, 20 swine producers (n = 20) were selected from each of the following swine producing areas in the Free State Province:

- Bloemfontein/Botshabelo;
- Kroonstad;
- Thaba-Nchu; and
- Qwa-Qwa

To determine the sample size for the study, Tara Yamani formula in (Mac'odo 2002) was applied thus:

$$n = \frac{N}{1 + N\,(e)^2}$$

Where: n = sample size sought

N = population size = 100

e = level of significance (0.05

At 0.05 level of significance where N = 100

$$n = \frac{100}{1 + 100\,(0.05)^2}$$

$$= \frac{100}{1 + 100\,(0.05)^2}$$

$$= \frac{100}{1 + 0.25}$$

$$= \frac{100}{}$$

1.25 = 80

$\therefore$ n = 80

Sampling criteria

The sampling criteria are the characteristics essential to the membership of the target population. These criteria are the characteristics that delimit the population of interest (Burns & Grove 2012).

For this study the inclusion criteria were:

- The participant has to be recognized by the department of Agriculture of the Municipality under study.
- The participants have to be in the Swine farming business for not less than five years in operation. To achieve this, we worked with the staff of the department of Agriculture of the municipality we are studying.

5.11 Data Collection Techniques

There are different types of data collection techniques. The technique chosen depends on the research under consideration. Data collection techniques include:

1. Using available Information (Known as secondary data) – This involve use of checklist, literature, data compilation forms etc.
2. Observation: This method involves the use of the eyes and other senses. Pen/paper, watches, etc.
3. Interview: One on one discussion/questioning, tape recording, etc.
4. Administering written questionnaire (ie Primary source).

Use of questionnaire: Primary Data and Secondary Data sources were used for data collection in this study, but the overall dominance remains with the primary data.

5.11.1 Collection of Primary Data

In the case of descriptive research, the primary data can be collected either through observations or through direct communications with the respondents in one form or the other. Data was collected from three municipalities using structured questionnaires, in depths interviews with key informants. There were four research assistants. The communities with many pigs owning households were identified with the assistance of the Extension Officer and the local leadership. The questionnaires were administered in the local vernacular Sesotho

language using the snow ball sampling technique. The key informants were interviewed to establish the pig production trends, as a first step in designing a structured questionnaire.

5.11.2 Collection of Secondary Data

Though the real thrust in the study lies with the strength of immense amount of primary data collected with the help of structured questions, the study also employed the use of secondary sources. The secondary data information was gathered from various marketing journals, books, earlier related studies, reports and survey of government and non-government agencies in this regard press release, newspapers, periodicals and use of internet explore various useful sites in relation to study.

5.11.3 Processing and Analysis of Data

The data after collection were to be processed and analyzed with the requirement and purpose at the time of the development of the scale. It is essential for such a scientific study that only the relevant data should be used from the collection of such a voluminous data and processed through the proper statistical tools. Data were thoroughly evaluated before analysis. Data were analyzed with the help of Statistical Package for Social Sciences (SPSS package).

5.11.4 Qualitative data collection technique

Primary and secondary data as well as information from comprehensive literature surveys were used in this study. The principles identified in the literature will then form primary basis to identify the fundamental performance indicators through which marketing strategies in the Free State were evaluated. Market research projects/ surveys conducted through questionnaire administration to ascertain consumer perceptions, trends and preferences covering the period of 5-15 years was considered. Data will be gathered by means of a semi-structured and open-ended questionnaire, which will be distributed to the 80 swine producers at their various farms within Bloemfontein/Botshabelo; Kroonstad; Thaba-Nchu; and Qwa-Qwa. Questions was arranged in different Likert scale and the respondents will be asked to indicate their degree of agreement with the statement or any kind of subjective or objective evaluation of the statement regarding the issues of swine marketing strategies. A pilot survey involving 10 swine producers within the study area was conducted to ascertain the validity and reliability of the instrument used.

5.11.5 Data analysis techniques

For the purpose of this study, the results of the quantitative survey will be presented in Frequency Tables, Percentages, Means, Pearson Product Moment Correlation Co-efficient (PPMC), Regression analysis and t-test, analysis of variance (ANOVA).

5.12 Validity and Reliability of Instrument

The conclusion of any research endeavour to create a new agony for the researcher (Fubara & Mguni, 2005). This is true since other scholars or researchers would want to raise questions on the reliability and viability of the methodology, findings and generalizability of the study.
Validity test shows the level of ability of a scale to measure the intended concept. Dana (2001) saw validity as the degree to which an observation or a measurement corresponds to the construct that was supposed to be observed or measured.

Reliability and Validity 'of the measurement scale is generally the most important concept after preparing the scale. Reliability is concerned with the stability of test scores that it does not go beyond the test itself. Validity, on the other hand, implies evaluation in terms of outside and independent criteria.

A test is called reliable when we find the scores obtained are stable and trustworthy, which can be examined only through the measure that the scores are error free. As already discussed, the items of the test were divided into two sub-groups i.e. 25 percent in the upper and the 25 percent in the lower group, which are further corrected to eliminate chance success. The discrimination power (Validity index) of each item is 0.50 and more.

5.12.1 Validity

The validity of a test depends upon the fidelity with which it measures when it is supposed to measure. A test is said to be valid when the performances which it measures correspond to the same performance as otherwise independent measures are objectively defined.

In this study, reliability and validity was achieved through the adoption of the measures of constructs and scale used in some duly accepted research works. However, because of the difference between the sample size of the study and those from which the instrument was adopted, a pilot or pre-test study was carried out in Bloemfontein where there is a good representative of swine producers. According to Trochim (2006) reliability is the quality of measurement in terms of its consistency and repeatability. This implies that a reliable measure

is anticipated to give the same measurement of the same phenomenon each and every time it is used. Ahiauzu (2006) posit that a statistical tool called Cronbach's Alpha is a reliability coefficient that indicates how well, the Hems in a set are positively correlated to one another. From the pilot study conducted in Botshbelo/Thaba nchu, the result r =0.71 confirmed the reliability of the survey (See appendix 2).

5.13 Data Presentation and Analysis Techniques

The focus here was how the acquired data were prepared and presented. It involves a presentation, analysis and testing of the formulated hypotheses using the SPSS 20.0 version statistical tool.

For easy understanding, the data collected were presented and analyzed through the use of simple table frequencies and percentages; pie chart and bar chart.

CHAPTER 6

FINDINGS OF THE RESEARCH

6.1 Introduction

The previous chapters focused predominantly on research objectives, theoretical underpinnings, and the framework for data collection and hypotheses testing. In order to address the research objectives research questions and research hypotheses, in this chapter, we present, analyze, and interpret the field data collected with structured questionnaires. Descriptive statistics (e.g., tables and simple percentages, bar charts, and pie charts), and parametric inferential statistics were used to aid analyses.

6.2 Demographic/Profile Analysis

Data collected with the structured questionnaire on the demographic /profile of the respondents and the firm were subjected to statistical scrutiny. Relevant tables and charts reported in this section show subjects' responses to issues bordering on gender, age, educational attainment, and marital status. For appropriate description, bar charts and pie charts were also used to present the frequencies. (See Appendix 5 for the Demographic Table)

Sex of Respondents; the researcher requested that respondents should indicate their sex. Section 1 of table 6.1 (see appendix 2) reveals that 47(58.8%) of the respondents were Male while 33(41.3%) were Female. This is also Shown in the bar chart in figur 6.1 Below.

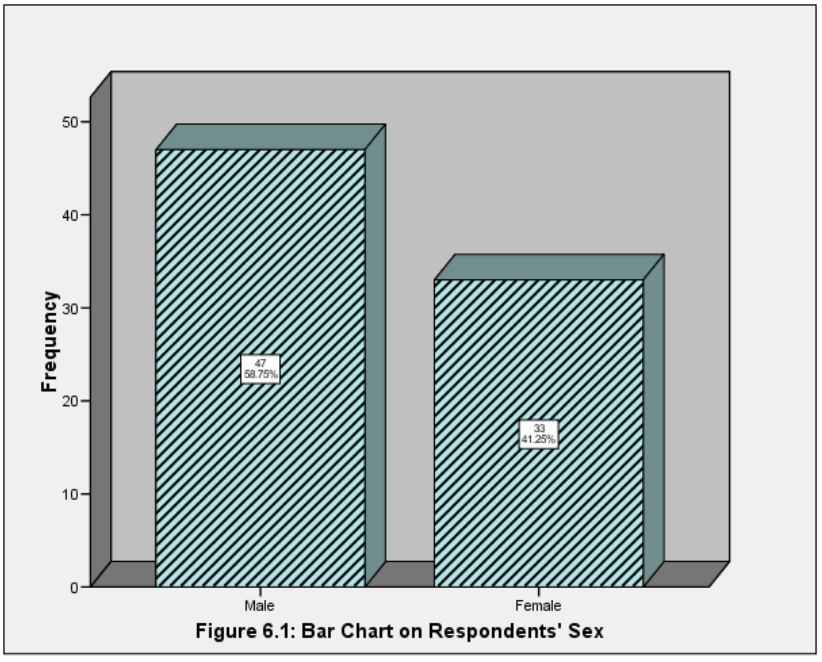


Figure 6.1: Bar Chart on Respondents' Sex

As regards the age of the respondents, section 2 of table 6.1 shows that majority of the respondents, 58(72.5%) were within the age bracket of 46 to 65 years. Specifically, 28(35%) of the respondents were within 46 to 55 years, 30(37.5%) were within the age bracket of 56 to 65 years, and 5(6.3%) were over 66 years old. However 4(5%) were within the age bracket of 25 to 35 years. This is an indication that the respondents were mature enough to have given reliable information. The result is shown in the bar chart in figure 6.2 below.

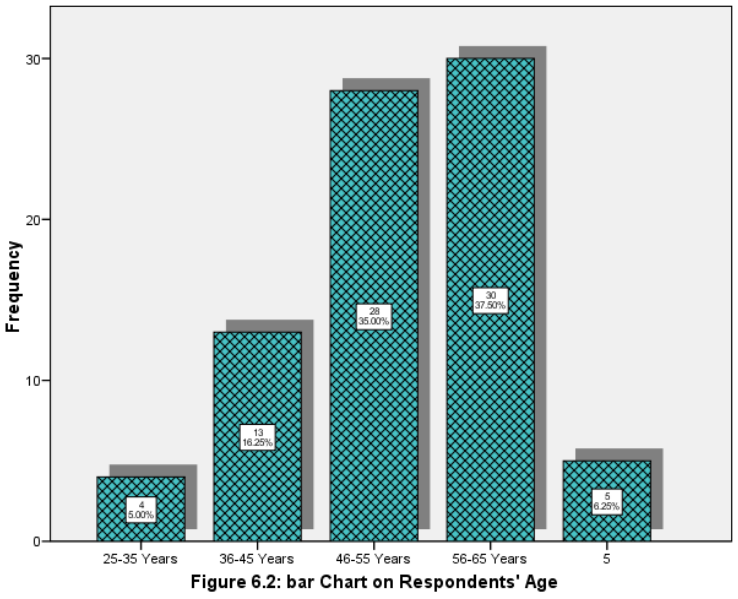


Figure 6.2: bar Chart on Respondents' Age

The assessment of how long the Respondents have been in Swine Enterprise shown in Section 3 of table 6.1 above shows that 24(30%), and 7(8.8%) of the respondents were in swine business for 5 to 10 years and 11 to 15 years respectively. 13 (16.3%) of the respondents were had been in swine enterprise for over 16 years. However, majority of the respondents 36(45%) were in swine enterprise within 1 to 4 years. This indicated the 55% of the respondents had been in the business for at least 5 years. This information is represented in figure 6.3 below.

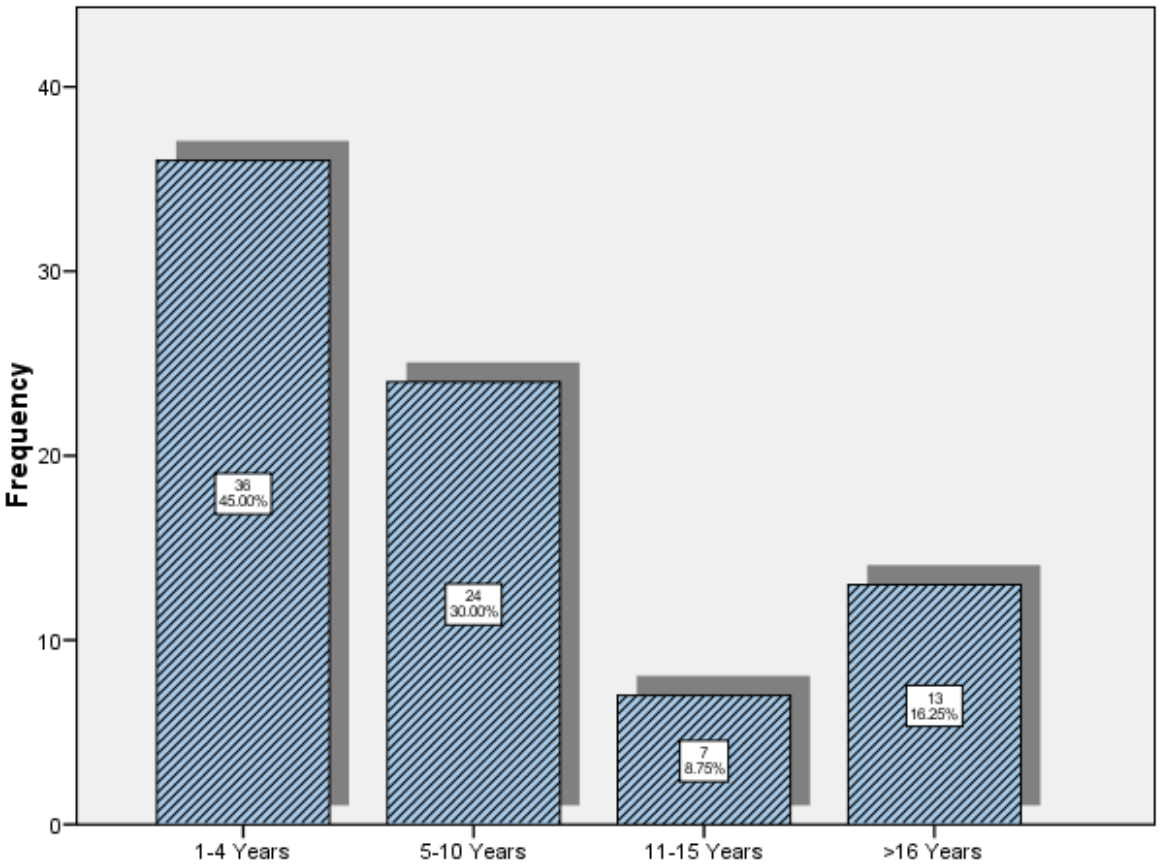


Fig 6.3: Bar Chart showing how long the Respondents have been in Swine Enterprise

As regards the marital status of the respondents, section 4 of table 6.1 above shows that majority of the respondents 56(70%) were married while 2(6.3%) were single. On the other hand, only 17 representing just 21.3% of the respondents were widowed while 2(2.5%) of the respondents were divorced. From the result, it is fair enough to say that the respondents were responsible. See bar chart on Marital Status of the Respondents in figure 6.4 below

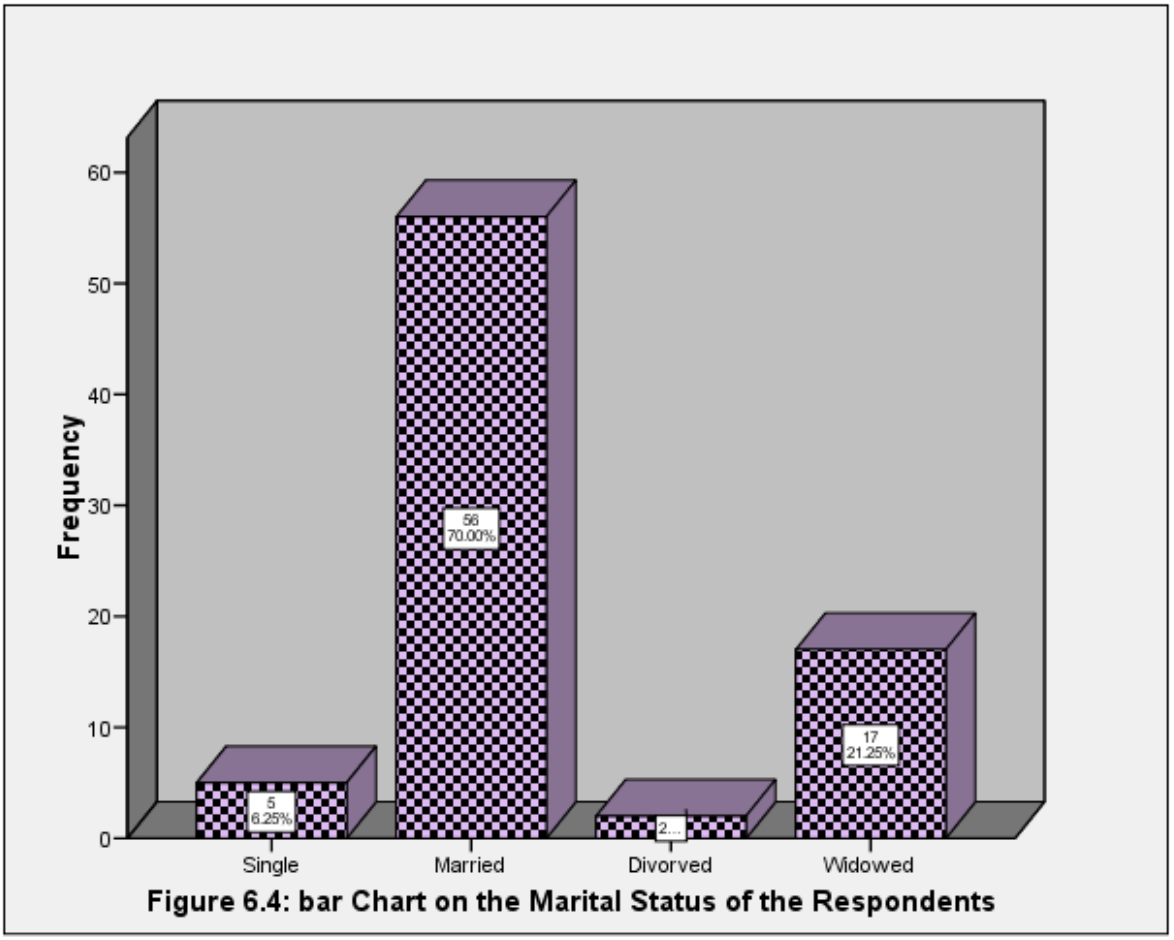


Figure 6.4: bar Chart on the Marital Status of the Respondents

Household Size of the Respondents; Section 5 of table 6.1 showed that 34 (42.5%), of the respondents indicated none, 23(28.8%), and 16 (20%) had family members within 1 to 3 and 4 to 6 respectively. However, 7 (8.8) of the respondents established that their house hold size was over 6. This is shown in the pie chart in figure 6.5 below.

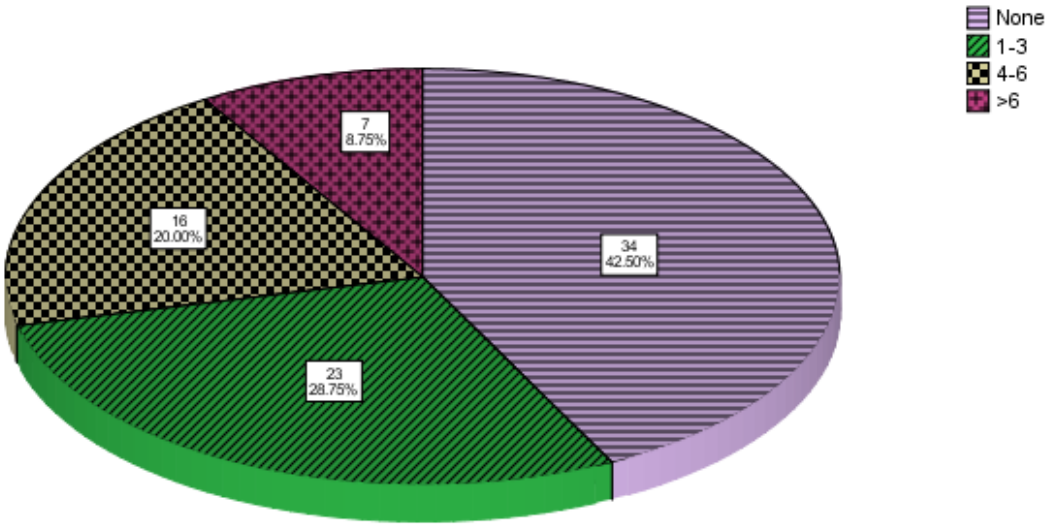


Figure 6.5: Pie Chart showing Household Size of the Respondents

Race of the Respondents; The researcher requested that respondents should indicate their race. Section 6 of table 6.1 (see appendix 7) reveals that 78(97.5%) of the respondents were from the black race while 2(2.5%) were white. This is also Shown in the bar chart in figur 6.6 Below.

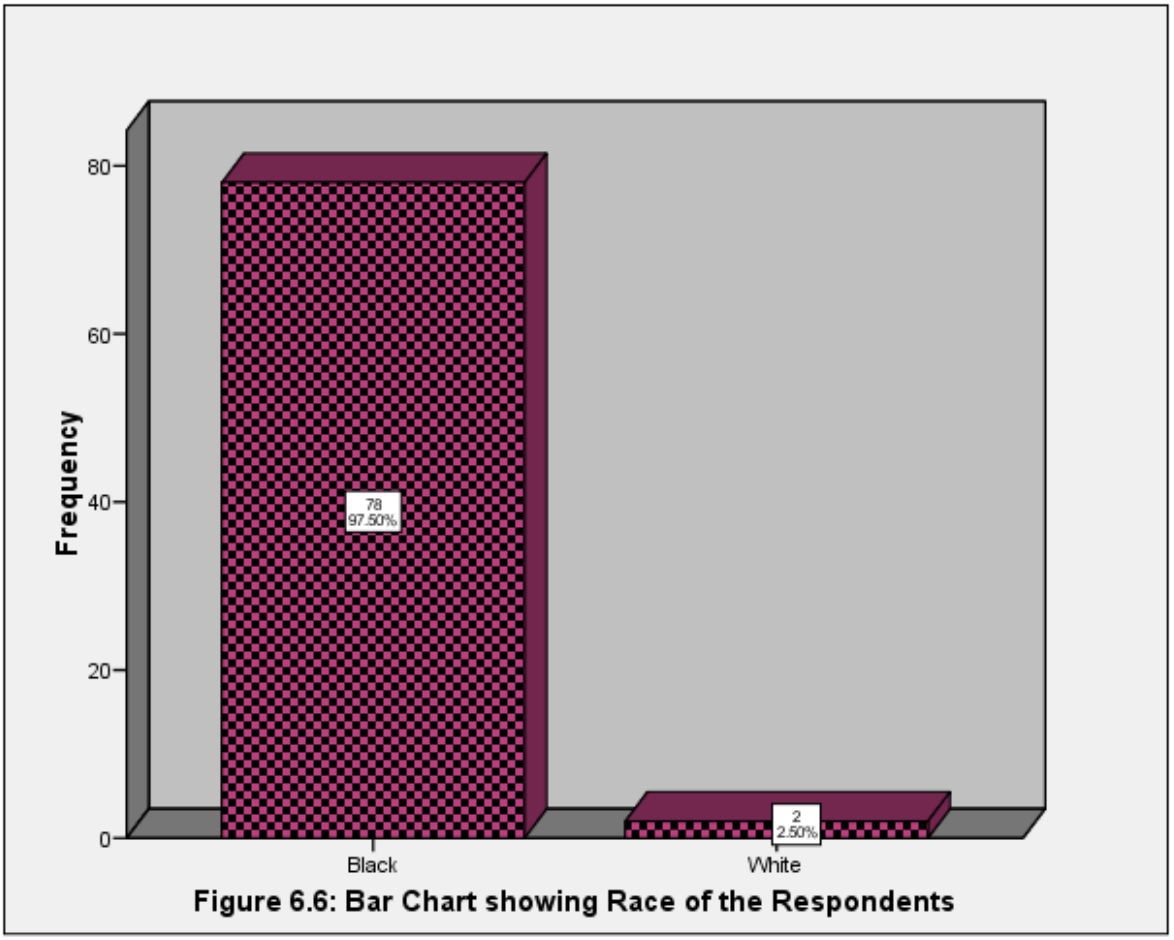


Figure 6.6: Bar Chart showing Race of the Respondents

Respondents who send their Swine to the Abattoir; The researcher also requested that respondents should indicate if they send their Swine to the Abattoir. Section 6 of table 6.1 (see appendix 7) reveals that 78(97.5%) of the respondents were from the black race while 2(2.5%) were white. This is also Shown in the bar chart in figur 6.7 Below.

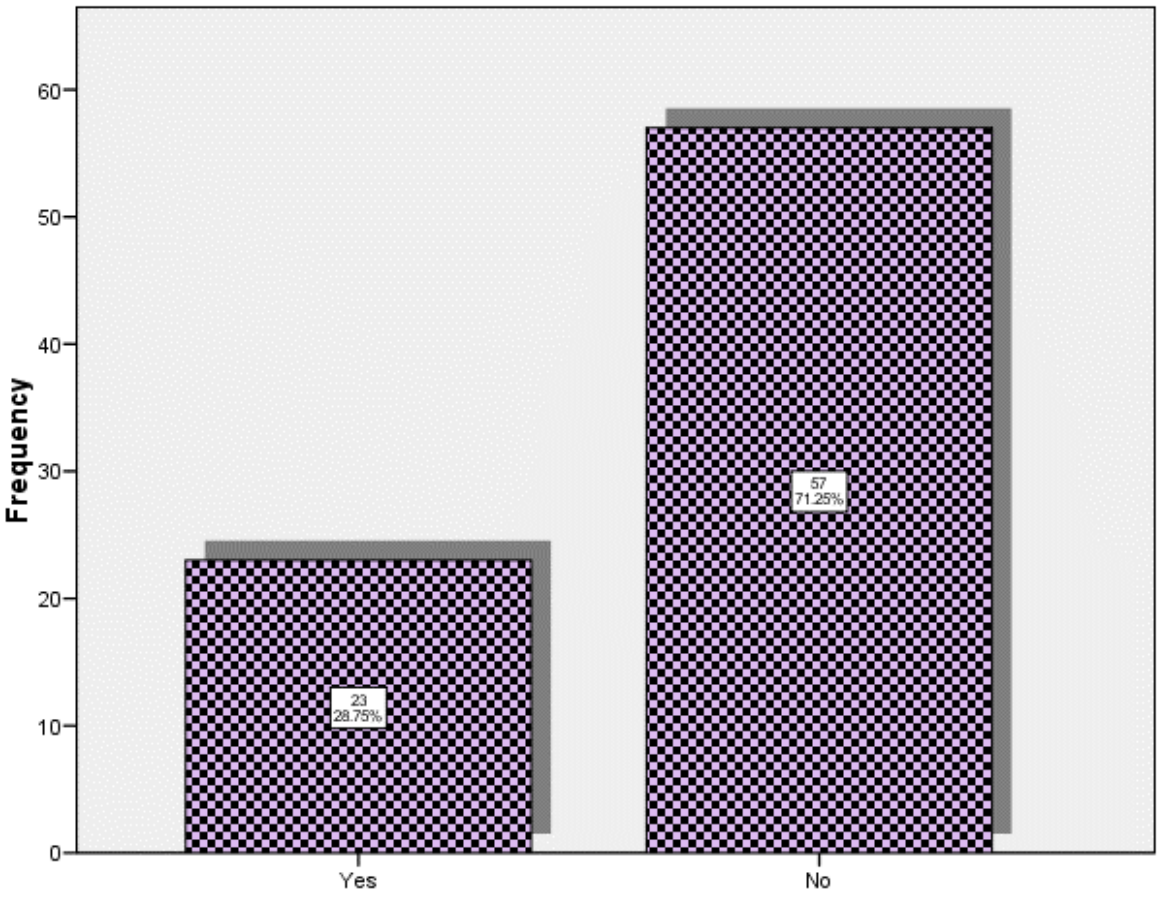
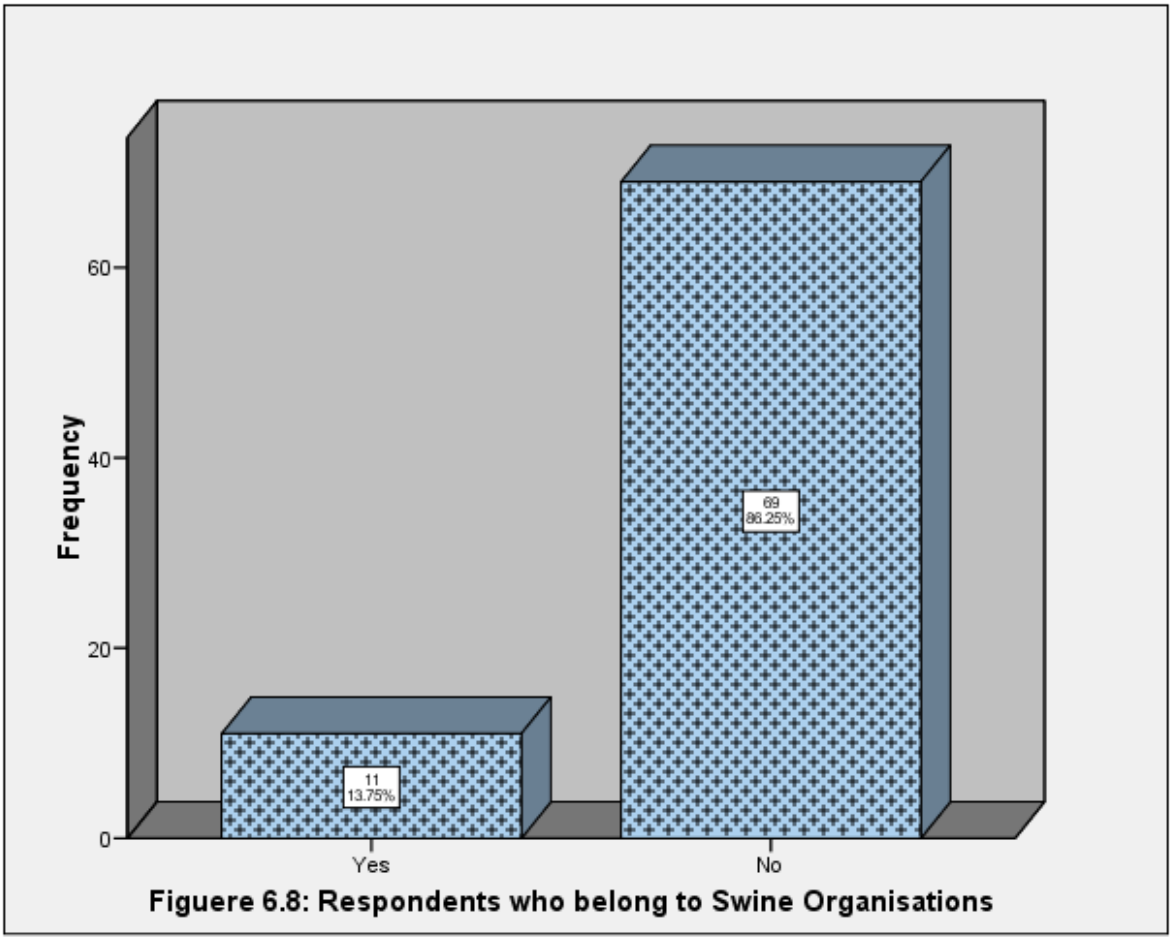


Figure 6.7: Respondents who send their Swine to the Abattoir

Respondents who belong to Swine Organisations; The researcher requested that respondents should indicate if they belong to Swine Organisations. Section 7 of table 6.1 (see appendix 8) reveals that 11(13.8%) of the respondents were members of swine orgaanisations while 69(86.3%) were not. This is also Shown in the bar chart in figur 6.8 Below.



Figuere 6.8: Respondents who belong to Swine Organisations

Age of the Respondents' Children; As regards the age of the respondents' children, section 8 of table 6.1 shows that majority of the respondents, 26(22.5%) had children within the age bracket of over 20 years old. Though 24(30%) of the respondents were not applicable, this may be because they were single or because they don't or were yet to have children. More so, 18(22.5%) and 7(8.8%) of the respondents were had children within16 to 20 years and 11 to 15 years respectively. This is an indication that 70% 0f the respondents had at least a child. The result is shown in the pie chart in figure 6.9 below.

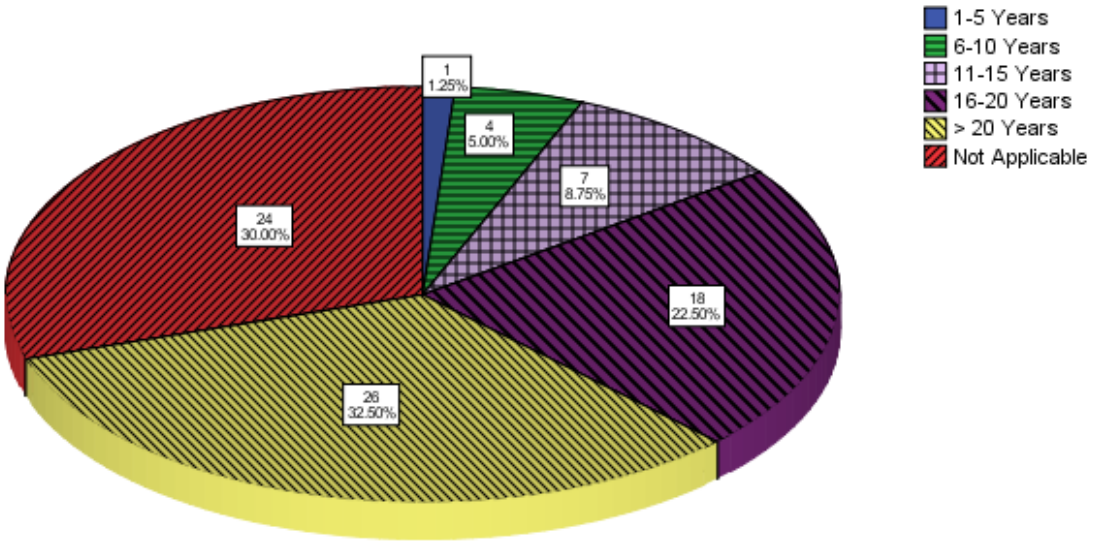


Figure 6.9: Pie Chart Showing the Age of the Respondents' Children

Educational Qualification of the Respondents; The academic qualification of the respondents as shown in section 9 of table 6.1 indicates that 10(12.5%) of the respondents had no formal education. 22 (27.5%) of the respondents had grade 6. Majority of the respondents 33(41.3%) had matric. However, 5(6.3%), 5(7.5%), and 3(3.8%) of the respondents had National Certificate, Bachelor of Science Degree, and B. Tech. respectively. However, 1 (1.3%) of the respondents had a Master Degree. This information is shown in the pie chart in figure 6.10 below.

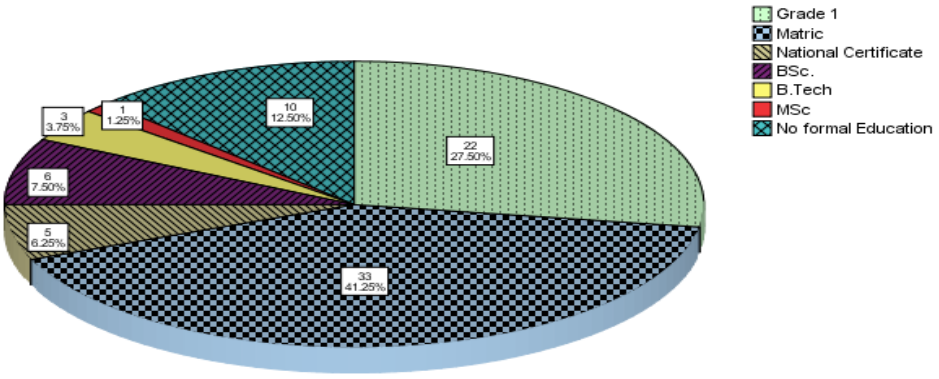


Figure 6.10: pie hart showing Educational Qualification of the Respondents

Gross income of the respondents; the gross income of the respondents as shown in section 11 of table 6.1 indicates that 13(16.3%) of the respondents had income level less than R1000. Majority of the respondents 35(43.8%) had income levels betwwen R1000 to R10,000. Furthermore, 11(13.8%), 2(2.5%), and 5(6.3%) of the respondents had income levels between R21,000 to R30.000, and R31000 to R40.000, respectively. However, 9 (11.3%) of the respondents had income levels above R50,000. This information is shown in the pie chart in figure 6.11 below.

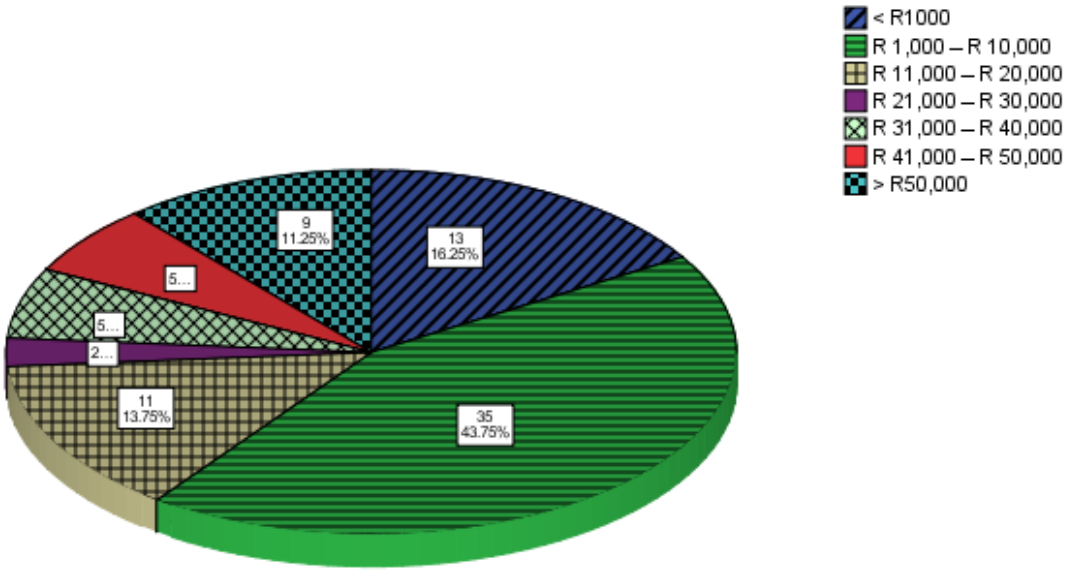


Figure 6.11: Pie Chart showing Gross Income of the Respondents

Marketing Channels used by the Respondents; as shown in section 12 of table 6.1 indicates that 6(7.5%) of the respondents used wholesalers, while 19(23.8%) used Butchers. Majority of the respondents 35 (43.8%) used the retailers. 8 (10%) and 12 (15%) of the respondents used neighbours and Farm Market as their distribution channels. This information is shown in the pie chart in figure 6.12 below.

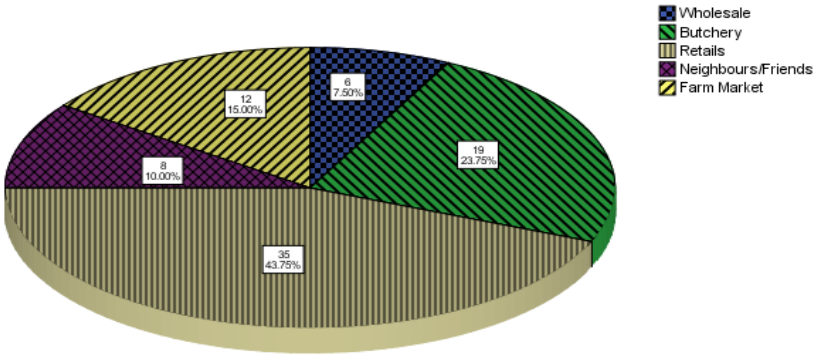


Figure 6.12 Pie Chart showing Marketing Channels used by the Respondents

6.3 Univariate Analysis

Table 6.2 Marketing Channels used by the Respondents

Which of the following marketing channels do you use?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Wholesalers	6	7.5	7.5	7.5
	Butcheries	13	16.3	16.3	23.8
	Retailers	8	10.0	10.0	33.8
	Neighbours/Friends	29	36.3	36.3	70.0
	Farmers Market	8	10.0	10.0	80.0
	Cooperatives	4	5.0	5.0	85.0
	Auction	12	15.0	15.0	100.0
	Total	80	100.0	100.0	

Source: Field Survey 2015

Frequency Table 6.2 above shows the frquency distribution of the marketing channels adopted by the respondents. The result shows that majority of the producers 36.3%(29) sell directly to Neighbours/friends, while 16.3%(13), 15.0%(12), 10%(8), and 10%(8) of the respondents sell directly to Butcheries, Auction, Retailers, and Farmers market respectively.

Table 6.3 Swine Send to the abatoir

Do you send your swine to the abattoir?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	23	28.8	28.8	28.8
	No	57	71.3	71.3	100.0
	Total	80	100.0	100.0	

The result above showed that 71.3%(57) of the respondents do not send their swine to the abatoir while only 28.8(23) do send.

Table 6.4 (a) Organizational Affliation

Do you belong to any swine organisation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	11	13.8	13.8	13.8
	No	69	86.3	86.3	100.0
	Total	80	100.0	100.0	

Table 6.4 (b) Organizational Affliation

I yes name the swine organisation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Itshokolele	2	2.5	18.2	18.2
	Metsi-matsho peggery	2	2.5	18.2	36.4
	NERPO;RMPO	2	2.5	18.2	54.5
	Motebog piggery	3	3.8	27.3	81.8
	Makware	2	2.5	18.2	100.0
	Total	11	13.8	100.0	
Missing	System	69	86.3		
Total		80	100.0		

Table 6.4 indicated that 86.3%(69) do not belong to any swine association while 13.8%(11) of the respondents belong to an organization. Table 6.4(b) shows the names of swine association they are affliated to.

Table 6.5 (a) Swine Producers Cooperative

Would you like to belong to any swine producers cooperatives?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	53	66.3	66.3	66.3
	No	27	33.8	33.8	100.0
	Total	80	100.0	100.0	

Table 6.5 (b) Swine Cooperative

I yes name the producers cooperatives/body?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Makwane piggery	4	5.0	7.5	7.5
	SAPO	36	45.0	67.9	75.5
	Motebog piggery	5	6.3	9.4	84.9
	SAVPO	4	5.0	7.5	92.5
	Others	4	5.0	7.5	100.0
	Total	53	66.3	100.0	
Missing	System	27	33.8		
Total		80	100.0		

Majority of the respondents 66.3%(53) would love to belong to a cooperative and the names of the cooperatives they will like to belong are indicated in table 6.5(b). The result shows that majority of the farmers would like to belong to an association. This really shows the quest to inprove their swine farming production.

Table 6.6 Size of Pen

What is the size of your pen?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10.5 m2	33	41.3	41.3	41.3
	11 m2	14	17.5	17.5	58.8
	11.5 m2	11	13.8	13.8	72.5
	4.00	22	27.5	27.5	100.0
	Total	80	100.0	100.0	

Table 6.6 above showed that majority of the respondents 41.3%(33) has 10.5m2 as the size of their pen while 17.5%(14), 13.8%(11), and 27.5%(22) has 11m2, 11.5m2, and 4.0m2 as the size of their pen respectively.

Table 6.7 Size of Farrowing Units

What is the size of your farrowing units?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2 m2	23	28.8	28.8	28.8
	3-4 m2	30	37.5	37.5	66.3
	5-6 m2	6	7.5	7.5	73.8
	7 m2 and above	2	2.5	2.5	76.3
	No farrowing units	19	23.8	23.8	100.0
	Total	80	100.0	100.0	

Table 6.7 indicated that 37.55(30) of the respondent has a farrowing unit of 3-4m2, whereas 28.8%(23), 7.5%(6), and 2.5%(2) has a farrowing unit of 2m2, 5-6m2, and 7m2 and above respectively. The result also show that 23.8%(19) of the respondents has no farrowing unit at all.

Table 6.8 Average piglet produced

What is the average piglet produced by one sow?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	17	21.3	21.3	21.3
	10	52	65.0	65.0	86.3
	15	11	13.8	13.8	100.0
	Total	80	100.0	100.0	

The information above showed that 65.0%(52) of the respondents said that one Sow produces an average of 10 piglet, while 21.3%(17), and 13.8%(11) produces 5 and 15 piglets respectively.

Table 6.9 Piglets Survival at Weaning

How many piglets survive at weaning?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	30	37.5	37.5	37.5
	1-5	32	40.0	40.0	77.5
	6-10	5	6.3	6.3	83.8
	11-15	13	16.3	16.3	100.0
	Total	80	100.0	100.0	

The result above showed that 40%(32) of between 1-5 piglets survive at weanning, while 16.3%(31), and 6.3%(5) of between 11-15 and 6-10 piglets survive at weanning respectively. The result further showed that 37%(30) of the respondents said that non of the piglets survive at weanning.

Table 6.10 Overcrowding and piglet's mortality

Do you consider overcrowding as one of the causes of piglet mortality?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	49	61.3	61.3	61.3
	No	31	38.8	38.8	100.0
	Total	80	100.0	100.0	

The information above indcated that 61.3%(49) of the rsepondents believed that overcrowding causes piglet's mortality while 38.8%(31) do not believe.

Table 6.11 Age at Marketing the Swine

At what age do you maket your swine?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2-3 months	16	20.0	20.0	20.0
	4-5 months	20	25.0	25.0	45.0
	6-7 months	26	32.5	32.5	77.5
	8 months and above	14	17.5	17.5	95.0
	5.00	4	5.0	5.0	100.0
	Total	80	100.0	100.0	

Tabble 6.11 above showed that 32.5%(26) of the respondents market their swine at between the ages of 6-7months, whereas 25.0%(20), 20.0%(16), and 17.5%(14) of the respondents market theirs between the ages of 4-5months, 2-3months and 8months and above respectively.

Table 6.12 Cost to Raise 100kg Body Weight

How much does it cost to raise 100kg body weight?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	R100-R200	8	10.0	10.0	10.0
	R200-R300	32	40.0	40.0	50.0
	R300-R400	26	32.5	32.5	82.5
	R400-R500	5	6.3	6.3	88.8
	R500 and above	9	11.3	11.3	100.0
	Total	80	100.0	100.0	

The information above showed that 40.0%(32) of the respondents raise their swine to body weight of 100kg at the cost of between R200-R300. Furthermore, the result showed that 32.5%(26), 11.35(9), 10.0%(8), and 6.3%(5) raise their swine body weight to 100kg at the cost of between R300-R400, R500 and above, R100-R200 and R400-R500 respectively.

Table 6.13 Transportation Cost to the Market/Abattoir

How much does it cost to transport on swine to the markrt or abattoir?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	R50-R100	25	31.3	31.3	31.3
	R100-R150	28	35.0	35.0	66.3
	R150-R200	26	32.5	32.5	98.8
	R250-R300	1	1.3	1.3	100.0
	Total	80	100.0	100.0	

The above result indicated that 35.0%(28) of the respondents spent between R100-R150 as transportattion cost to the market/abbatoir. Followed closely are 32.5%(26) and 31.3%(25) spent between R150-R200 and R50-100 respectively as transportation cost to the market/abbatoir. Only 1.3%(1) of the respondent spend between R250-R300.

Table 6.14 Distance from Farm to the Market/Abbatoir

What is the distance from the farm to the market or abattoir?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-20m	46	57.5	57.5	57.5
	20-40m	16	20.0	20.0	77.5
	40-60m	11	13.8	13.8	91.3
	60-80m	7	8.8	8.8	100.0
	Total	80	100.0	100.0	

The information above showed that 57.5%(46) of the respondents' distance from thier farm to the market/abbatoir is between 1-20miles. Also 20.0%(16), 13.8%(11), and 8.8%(7) of the respondents' distance from farm to market were between 20-40miles, 40-60miles and 60-80miles respectively.

Table 6.15 Government Policies and the Marketing of Swine

To what extent does government policies affect the marketing of your swine?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Extent	4	5.0	5.0	5.0
	Very low extent	5	6.3	6.3	11.3
	Low extent	2	2.5	2.5	13.8
	Moderate extent	11	13.8	13.8	27.5
	High extent	32	40.0	40.0	67.5
	Very high extent	26	32.5	32.5	100.0
	Total	80	100.0	100.0	

Table 6.15 showed that 40.0%(32) and 32.5%(26) of the respondents agreed that goverment policies affect the marketing of swine at a high and very high extent respctively. Whereas 13.8%(11), 6.3%(5), 5.0%(4), and 2.5%(2) said that government policies affect them at moderate, very low, no, and low extent respectively.

Table 6.16 Trade Union Registration and Effect on Marketing of Swine

Does trade union registration have any effect on the marketing of your swine?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	18	22.5	48.6	48.6
	No	19	23.8	51.4	100.0
	Total	37	46.3	100.0	
Missing	System	43	53.8		
Total		80	100.0		

The result above showed that majority of the respondents 23.8%(19) do not believe that trade union registration has effect on the marketing of thier product, while 22.5%(18) believe that trade union registration has effect.

Table 6.17 Access to Government Subsidies

Do you have access to government agricultural subsidies?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	5.0	5.0	5.0
	No	76	95.0	95.0	100.0
	Total	80	100.0	100.0	

The result above showed that 95.0(76) of the farmers do not have access to government agricultural subsidies, while only 5.0(4) of the farmers has access to the subsidies.

Table 6.18 Access to Government Bank Loan

Do you have access to government bank loan?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	3.8	3.8	3.8
	No	77	96.3	96.3	100.0
	Total	80	100.0	100.0	

The information on table 6.18 showed that 96.3%(77) of the farmers do not have access to government bank loan, while a fraction of 3.8%(3) said they had access to government bank loan.

Test of Hypotheses 1 and 2

Decision Rule for test of hypotheses

If the Significant/Probability Value (PV) < 0.05 (Level of Significance*) = Reject the null and Conclude significant difference*

If the Significant /Probability value (PV) > 0.05 (Level of Significance) = Accept the null and Conclude Insignificant significant difference:

Conventionally; If the calculated value is greater than the critical value; reject the null and Conclude significant difference

If the If the calculated value is greater than the critical value; accept the null and Conclude insignificant difference:

Test of Hypothesis 1

HO_1: "There is no significant difference in the marketing chanels adopted by swine producers in Free State.

Table 6.19: Mean, Standard Deviation and t-test showing Significant Difference in the the Marketing Chanelsadopted by Swine Producers in Free State.

Responses	*N*	*Mean* $\bar{x}$	*SD*	*Df*	t_{-cal}	t_{-crit} *(0.05,79)*	*Sig. t*	*Level of significance*	*Dec.*
Marketing chanels adopted by swine producers in Free State	*80*	*3.01*	*1.127*	*79*	*1.0*	*1.98*	*0.921*	*0.05*	*Accepted*

Source; SPSS 20.0 output based on field survey data 2015, detail in appendix ….

The summary of t-test result on the difference in the marketing chanels adopted by swine producers in Free State showed that the t-calculated is |1.00| and the critical (table) value of $t_{(0.05, 79)}$ = 1.98. Since t_{cal} = |-1.00| < $t_{crit\ (0.05, 79)}$ = 1.98, the researcher consequently accepts the null hypothesis. More so, the sig. t (0.921) > 0.05 level of significance, the researcher consequently uphold the decision reached earlier and conclude that there is no significant difference in the marketing chanels adopted by swine producers in Free State.

Test of Hypothesis 2

HO_2: "There is no significant difference in the stocking rate adopted by swine producers in Free State.

Table 6.20: Mean, Standard Deviation and t-test showing Significant Difference in the the Stocking Rate adopted by Swine Producers in Free State.

Responses	*N*	*Mean* $\bar{x}$	*SD*	*Df*	t_{-cal}	t_{-crit} *(0.05,79)*	*Sig. t*	*Level of significance*	*Dec.*
stocking rate adopted by swine producers in Free State	*80*	*2.18*	*1.007*	*79*	*-2.77*	*1.98*	*0.007*	*0.05*	*rejected*

Source; SPSS 20.0 output based on field survey data 2015, detail in appendix ….

The summary of t-test result on the difference in the stocking rate adopted by swine producers in Free State showed that the t-calculated is |-2.77| and the critical (table) value of $t_{(0.05, 79)}$ =

1.98. Since t_{cal} = |-2.77| > $t_{crit\ (0.05,\ 79)}$ = 1.98, the researcher consequently rejects the null hypothesis. More so, the sig. t (0.007) < 0.05 level of significance, the researcher consequently maintained the decision reached earlier and concluded that there is a significant difference in the stocking rate adopted by swine producers in Free State.

Relationship between distance to market/abttoir and transportation cost

As specified in chapter five, the hypothesized relationship between some of the variables were tested using the Pearson's Product Moment Correlation coefficient as shown below.

However, having explored the variables of the study in the univariate analysis, this section therefore seeks to establish if any relationship exists between the variables; if it does, measure it, identify the direction and also determine if the relationship is significant.

Table 6.21: Description on Range of correlation (r) values and the corresponding Level of Association

Range of r with positive and negative sign values	Descriptive level of Association
± 0.80 – 1.00	very strong
± 0.60 – 0.79	Strong
± 0.40 – 0.59	Moderate
± 0.20 – 0.39	Weak
± 0.00 – 0.19	Very weak

Source: Researcher's desk

The positive (+) sign in the values of r indicates a direct/positive relationship, while negative (-) of r indicates an indirect/negative or inverse relationship. Thus the sign of the r explains the direction of association or relationship between the two variables. Also in order to determine the strength of the relationship (if any) between the variables, we consider the magnitude of the correlation coefficient.

6.2.1 Relationship between distance to market/abattoir and transport cost

Table 6.22 Correlation Analysis showing the Relationship between distance to market/abattoir and transport cost

Correlations

		Distance to the market/abattoir	Transportion cost
Distance to the market/abattoir	Pearson Correlation	1	.496**
	Sig. (2-tailed)		.000
	N	80	80
Transportion cost	Pearson Correlation	.496**	1
	Sig. (2-tailed)	.000	
	N	80	80

**. Correlation is significant at the 0.01 level (2-tailed).

Source: SPSS 20.0 Output based on data in appendix 1, detail result in Appendix 3

Table 6.22 shows that the Pearson correlation coefficient (r) = 0.496, this value is moderate following the categorisation in table 6.22, implying that a moderate relationship exist between distance to market/abattoir and transport cost. The positive sign of the correlation coefficient is an indication that a direct relationship exist between them. That is to say that increase in distance to market/abattoir is driectly associated with increased transport cost.

Test of Hypothesis 3

HO_3 there is no significant relationship between distance to market/abattoir and transport cost. Table 6.22 showed that the Significant Value/Probability Value (PV) = 0.000 < 0.05 (level of significance) therefore the researcher rejects the null hypothesis and concluded that a positive, moderate, and significant relationship exist between distance to market/abattoir and transport cost.

Decision Rule for Test of Hypotheses 4, 5, 6, and 7

If the Significant/Probability Value (PV) < 0.05 (Level of Significance*) = Reject the null and Conclude Significant Influence*

If the Significant Probability value (PV) > 0.05 (Level of Significance) = Accept the null and Conclude Insignificant Influence

Or

If t-calculated Value > t-tabulated, = Reject the null and Conclude Significant Influence

If t-calculated Value < t-tabulated = Accept the null and Conclude Insignificant Influence:

Test of Hypothesis 4, 5, 6, and 7

Ho_4 Production cost does not significantly affect Gross income of Swine Producers in Free State

The test of significance conducted as shown in table 6.23 above shows that; Production cost had a probability Value (PV) = 0.000 < 0.05(level of significance) hence the researcher consequently rejects the null hypothesis. More so, t-cal = |-18.72| > $t\text{-tab}_{(0.05,\ 79)}$ = 1,98 the reasercher upheld the earlier decision and conclude that Production cost significantly affect Gross income of Swine Producers in Free State (note that the negative sign of the t-value is an indication that increase in production cost is associated with decrease in gross income of swine producers in the study area).

Ho_5 Access to government agricultural subsidy does not significantly affect Gross income of Swine Producers in Free State

The test of significance conducted as shown in table 6.23 above shows that; Access to government agricultural subsidy had a probability Value (PV) = 0.189 > 0.05(level of significance). More so, t-cal = 1.325 < $t\text{-tab}_{(0.05,\ 79)}$ = 1,98 the researcher consequently accepts the null hypothesis and conclude that Access to government agricultural subsidy does not significantly affect Gross income of Swine Producers in Free State

Ho_6 Access to bank loan does not significantly affect Gross income of Swine Producers in Free State

The test of significance conducted as shown in table 6.23 above revealed that; Access to bank loan had a Probability Value (PV) = 0.866 > 0.05(level of significance). More so, t-cal = 0.169 < $t\text{-tab}_{(0.05,\ 79)}$ = 1,98 the researcher consequently accepts the null hypothesis and conclude that Access to bank loan does not significantly affect Gross income of Swine Producers in Free State

Ho_7 Membership of swine organisation does not significantly affect Gross income of Swine Producers in Free State

The test of significance conducted as shown in table 6.23 above revealed that; Membership of swine organisation had a Probability Value (PV) = 0.629 > 0.05(level of significance). More so, t-cal = 0.485 < $t\text{-tab}_{(0.05,\ 79)}$ = 1,98 the researcher consequently accepts the null hypothesis and conclude that membership of swine organisation does not significantly affect Gross income of Swine Producers in Free State

6.3 Discussion of Findings

Developing a marketing model to assist swine producers maximize their profit in the Free State has been considered and researched. Also, a survey was carried out among the swine producers in the selected municipality of the Province and data analysis was presented based on the findings. Here we are going to discuss our findings as it relates to other published material on the subject.

Our finding on the significance difference in the marketing channel adopted by the Free State showed that majority of the farmers preferred selling direct to neighbours/friends and the butcheries. This is in contrast to the existing marketing channel of the RSA Agricultural, Forestry & Fisheries (refer to fig. 3.1, page 158). Our finding also concluded that there is no significant difference in the marketing channels adopted by swine producers in Free State.

The research findings indicated that majority of the farmers do not follow the best management standard for the stocking rate. This has led to overcrowding, which in has led to death of both sows and piglets. Many of the surveyed farmers said that they lost all their piglets during weaning. Also overcrowding contributed much to abortions experienced by the sows. From the findings the researchers concluded that there is a significant difference in the stocking rate adopted by swine producers in Free State. This result supports the report of Gonyou et al. (2006) and Torrallardona and Roura (2009). Also, Brumm et al. (2001) asserted that when growing-finishing pigs are given less than optimal space per pig, feed intake always decreases often resulting in a reduction in average daily gain (ADG), with variable effects on the gain. Crowding can result in depressed pig performance while under stocking can cause reduced pig meat output. Stocking density has a significant impact on growth performance. Stocking rate can have a major impact on the intake of feed as a result of space restrictions.

The researchers findings further proved that bad road, distance to the market/abbatoir contributed to the increase in the transportation cost. This thus affected the production cost and this invariably affected the gross income of the farmer. The result of the study agrees with other studies that supports the view that short as well as long transportation times can be detrimental to animal welfare, (Brown et al., 1999; Fortin 2002; Pérez et al., 2002; Mota-Rojas et al., 2006; Becerril-Herrera et al., 2010; Sutherland et al., 2012; Weschenfelder et al.,2012; Goumon et al., 2013; Weschenfelder et al., 2013; Sommavilla et al., 2017). However, longer duration transports have the added limiting factor of prolonged time off feed and water, especially considering that fasted pigs must rely on body energy reserves to survive and cope with transport and handling stress. This has led to

transport losses which refers to pigs that die or become non-ambulatory at any stage of the marketing process, defined as movement from the grower-finisher environment to stunning at the abattoir. Pigs that die during transport are referred to as “dead on arrival,” whereas pigs that dies after having been unloaded are termed “dead in yard” or “dead in pen.” These loses contribute greatly to the profit that accruable to the producer/farmer. (Anderson et al., 2002). Therefore the hypothesis confirmed that increase in distance to market/abattoir is driectly associated with increased transport cost. The researcher concluded that a positive, moderate, and significant relationship exist between distance to market/abattoir and transport cost.

Conclusion was reached that Production cost significantly affected Gross income of Swine Producers in Free State (since increase in production cost is associated with decrease in gross income of swine producers in the study area).

While the farmers complained not having access to government loan subsidy, the researcher dicovered that those that recieved subsidy from the government were comfortable. There are various grants, funding and incentives that have been made available by the government in an effort to assist new entrants and existing farmers in developing agriculture. In support of this, Nicole (2015) however posited that successful funding and business support in agriculture will go a long way to starting the business of your dreams, or growing your existing farm into a sustainable agribusiness.
The Free State Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA) established the programme called *Masibuyele esibayeni*, meaning *back to the kraal* (i.e. returning to the land). The programme is aimed at helping the small-holder farmers to upgrade and boost productivity by improving the genetic pool of their livestock. For the pig component, DARDLEA provides farmers with 10 sows and 1 boar with improved genetics for breeding and provides supportive services to such farms. it plays a major role in poverty reduction and food security (FAO, 2004) and provides a form of investment, emergency cash and meat for home consumption (Drucker & Anderson 2004; Mhlanga 2002). Although human needs are insatiable, the result proved that that Access to government agricultural subsidy does not significantly affect Gross income of Swine Producers in Free State. This result is also applicable to bank loans. Majority of the farmers do not have access to bank loan but the result showed that Access to bank loan does not significantly affect Gross income of Swine Producers in Free State’ Majority of the farmers do not belong to any swine organisation; they will be interested to belong to an organization. Some believed that the organization will bring about bureaucracy to their business. This could be the reason of the conclusion drawn from the research that membership of swine organisation does not significantly affect Gross income of Swine Producers in Free State.

CHAPTER 7

SUMMARY OF FINDINGS CONCLUSION, RECOMMENDATIONS AND PRESENTATION OF NEW MODEL

7.1 Introduction

This chapter presents the entire summary of the work, putting into consideration the objectives of the study. Also considered in this chapter is the conclusion drawn from the statistically proven results of the tested hypotheses. The chapter will further consider some recommendations that will help professional marketers to better their marketing strategies with respect to developing a marketing model that will assist Swine producers to maximize profits in the Free State. Finally, presentation of a new model and marketing channel that will assist the Swine producers in the Free State to maximize profits will be discussed.

7.2 Summary of the Study

Agricultural product market is changing from a predominantly producer dominated market approach to a demanding, well informed, consumer dominated market. Generally speaking the agricultural industry had become more industrialized and more specialized. This has imposed more pressure on management and business acumen. Swine production world over has increased due to technological advancements. Recently, the outbreak of swine fever (H1N1) in most part of the world, including South Africa has caused a lot of panic to the industry. This has led to the decline of swine consumption in the country including the Free State. It is then imperative that marketers should come to the aid of swine producers by developing an effective marketing model that will assist them to maximize their profit.

There is no documented Marketing Model available to assist the Free State swine producers maximize profits at least not the one the researcher is aware of. The traditional marketing system for swine by the Free State swine producers is characterized by independent producers and open market bargain. Most of the swine producers rely solely on prices negotiated in cash markets to establish base pork price.

The primary objective of this work which is to develop a Marketing Model that will assist Free State swine producers to maximize profit was achieved through the use of Primary Data and Secondary Data sources. The result of the quantitative survey was presented in Frequency

Tables, Percentages, Means, Pearson Product Moment Correlation Co-efficient (PPMC), Regression analysis and t-test, analysis of variance (ANOVA).

A consideration of the history of swine production around the world and in South Africa was made. Also, consideration of the production processes, the breeding systems, the products, the breeds available in South Africa, and the distribution both in the South African provinces and the world was looked in to.

Existing marketing models and marketing strategies that could apply in swine marketing was considered. These include market segmentation which involves dividing a market into distinct groups that might require separate marketing mix. This is important to swine producers, since they market their product by body weight. We also considered target marketing. While target marketing focuses on customers that have peculiar characteristics, the direct marketing strategy eliminates the middle men from distribution channel. Marketing models propounded by different authors and researchers including Rule of Thumb, Structure-Conduct-Performance, Commodity Chain Model, Transaction Cost Mode, and Stochastic Models were considered.

7.3 Summary of Findings

The findings are summarized thus:

- The demographic data analysis carried out showed the reliability of our sources of data since our respondents met with the required age of years in swine business. The result showed that 24(30%), and 7(8.8%) of the respondents were in swine business for 5 to 10 years and 11 to 15 years respectively. 13 (16.3%) of the respondents were had been in swine enterprise for over 16 years. However, majority of the respondents 36(45%) were in swine enterprise within 1 to 4 years. This indicated the 55% of the respondents had been in the business for at least 5 years.

- As regards the marital status of the respondents, the result showed that majority of the respondents 56(70%) were married while 2(6.3%) were single. On the other hand, only 17 representing just 21.3% of the respondents were widowed while 2(2.5%) of the respondents were divorced. From the result, it is fair enough to say that the respondents were responsible.

- The academic qualification of the respondents indicated that 10(12.5%) of the respondents had no formal education. 22 (27.5%) of the respondents had grade 6. Majority of the respondents 33(41.3%) had matric. However, 5(6.3%), 5(7.5%), and 3(3.8%) of the respondents had National Certificate, Bachelor of Science Degree, and B. Tech. respectively. However, 1 (1.3%) of the respondents had a Master Degree.

- After considering the demography of the study, a statistical tool (ANOVA) was used to test and confirm authenticity of the work. The following findings elucidated the answers to the research questions and objectives:

- The result showed that majority of the producers 36.3%(29) sell directly to Neighbours/friends, while 16.3%(13), 15.0%(12), 10%(8), and 10%(8) of the respondents sell directly to Butcheries, Auction, Retailers, and Farmers market respectively. The researcher therefore concluded there that is no significant difference in the marketing channels adopted by swine producers in Free State (refer Ho1).

- The result concluded that there is a significant difference in the stocking rate adopted by swine producers in Free State. Most of the swine farmers did not follow the standard stocking rate. This led to overcrowding in the stocking system and inadvertently caused abortion of the sows and death of piglets as the survey find out.

- It was revealed that 11(13.8%) of the respondents were members of swine orgaanisations while 69(86.3%) were not.

- The gross income of the respondents as shown in section 11 of table 6.1 indicates that 13(16.3%) of the respondents had income level less than R1000. Majority of the respondents 35(43.8%) had income levels between R1000 to R10,000. Furthermore, 11(13.8%), 2(2.5%), and 5(6.3%) of the respondents had income levels between R21,000 – R30,000 and R31,000 – R40,000 respectively. However, 9 (11.3%) of the respondents had income levels above R50,000.

- The result indicated that 37.55(30) of the respondent has a farrowing unit of 3-4m2, whereas 28.8%(23), 7.5%(6), and 2.5%(2) has a farrowing unit of 2m2, 5-6m2, and 7m2 and above respectively. The result also show that 23.8%(19) of the respondents has no farrowing unit at all. From the result it could be seen that many of the farmers do not meet up the standard of 2.7m x 1.8m according to Https://www.pig333.com>what the experts say.

- The information above showed that 65.0%(52) of the respondents said that one Sow produces an average of 10 piglet, while 21.3%(17), and 13.8%(11) produces 5 and 15 piglets respectively.

- The result showed that 40%(32) of between 1-5 piglets survive at weaning, while 16.3%(31), and 6.3%(5) of between 11-15 and 6-10 piglets survive at weaning respectively. The result further showed that 37%(30) of the respondents said that none of the piglets survive at weaning.

- The information indicated that 61.3%(49) of the respondents believed that overcrowding causes piglet's mortality while 38.8%(31) do not believe.

- The result showed that 95.0(76) of the farmers do not have access to government agricultural subsidies, while only 5.0(4) of the farmers has access to the subsidies.

- The information showed that 96.3%(77) of the farmers do not have access to government bank loan, while a fraction of 3.8%(3) said they had access to government bank loan.

- The result showed that majority of the respondents 23.8%(19) do not believe that trade union registration has effect on the marketing of their product, while 22.5%(18) believe that trade union registration has effect. They complained that the trade union bring about bureaucracy and increases the cost of the business.

- The information showed that 40.0%(32) and 32.5%(26) of the respondents agreed that government policies affect the marketing of swine at a high and very high extent respectively. Whereas 13.8%(11), 6.3%(5), 5.0%(4), and 2.5%(2) said that government policies affect them at moderate, very low, and low extent respectively.

- The result showed that 57.5%(46) of the respondents' distance from their farm to the market/abattoir is between 1-20miles. Also 20.0%(16), 13.8%(11), and 8.8%(7) of the respondents' distance from farm to market were between 20-40miles, 40-60miles and 60-80miles respectively.

- The result indicated that 35.0 %(28) of the respondents spent between R100-R150 as transportation cost to the market/abattoir. Followed closely are 32.5%(26) and 31.3%(25) spent between R150-R200 and R50-100 respectively as transportation cost to the market/abattoir. Only 1.3 %(1) of the respondent spend between R250-R300.

- The information showed that 40.0 %(32) of the respondents raise their swine to body weight of 100kg at the cost of between R200-R300. Furthermore, the result showed that 32.5%(26), 11.35(9), 10.0%(8), and 6.3%(5) raise their swine body weight to 100kg at the cost of between R300-R400, R500 and above, R100-R200 and R400-R500 respectively.

7.4 Conclusion

This study investigated the Marketing Model that will assist the Free State swine Producers maximize profit. Our theoretical framework was based on the early researchers on the topic. We considered some marketing strategies adopted by researchers, Accepted Best Management Practices (BMPs) in swine production, existing marketing models and early development of swine farming. Our research concentrated on swine producing municipalities of Free State province in South Africa.

Based on the evidence collated, analyzed, findings, and discussion elicited, the following conclusions arising therefrom are summarized thus. The primary conclusion drawn is that there is a significant relationship between the marketing channels adopted by the swine farmers in the Free State. The demography results indicate that the years of swine farmers in the business are above average since majority are more than ten years in the swine business.

Considering the different marketing channels adopted by the swine producers, the researcher concluded that there is no significant difference in the marketing channels adopted by swine producers in Free State. The researcher also maintained that there is a significant difference in the stocking rate adopted by swine producers in Free State. This could be seen in the various method of stocking rate adopted by the farmers.

On the relationship that exist between distance to abattoir and transport cost, the researcher rejects the null hypothesis and concluded that a positive, moderate, and significant relationship exist between distance to market/abattoir and transport cost. The researcher further upheld that Production cost significantly affect Gross income of Swine Producers in Free State. The researcher accepted the null hypothesis on the access to government agricultural subsidy and concluded that Access to government agricultural subsidy does not significantly affect Gross income of Swine Producers in Free State

Considering the access to bank loans, the researcher accepted the null hypothesis and concluded that Access to bank loan does not significantly affect Gross income of Swine

Producers in Free State. On the membership to swine organizations, the researcher accepted the null hypothesis and conclude that membership of swine organisation does not significantly affect Gross income of Swine Producers in Free State.

7.5 Recommendations and Presentation of New Model

The need for this study was anchored on the fact that many Swine producers typically market their pigs to several distributors, and this has reduced their profit maximization. Going through the results, findings, and conclusions reached based on scientifically and systematically conducted research work, the following recommendations are hereby forwarded.

- More youths should be encouraged to involve in pig farming. The research showed that majority of the farmers are aging if care is not taken swine farmers will go extinct.

- Government policy should encourage funding of the swine producers/ farmers.

- Swine producers should be given periodic training on the new technology available for the industry.

- The department of agriculture in conjunction with the extension officers (EOS) should have regular workshop to encourage the farmers.

- The farmers should be encouraged to join organizations that will boost their industry.

- Many of the farmers are not educated and so find it difficult to meet up with the modern technology in the industry. On this note, the government should make agricultural study compulsory in the matric level. They should also give grant to students who offer to study agriculture in the university.

- The government should subsidize or reduce tax for swine producers

- Finally access to government loan/bank loan should be made available.

Presentation of the New Model/ Marketing Channel

After considering the challenges faced by the Free State swine producers, the researcher came up with a marketing model that will help the farmers maximize their profit. Also the researcher

came with a simple marketing distribution channel that will reduce cost for both the consumers and the producers.

The model is presented below:

Regression Analysis showing the Effects of Production Cost, Access to Government Agricultural Subsidy, Access to Bank Loan, and Membership of Swine Organisation, on Gross income of Swine Producers in Free State..

Variables	*Coef*	*t-cal*	*sig. T*
Constant	*.220*	*.280*	*.78 0*
Cost of production	*-1.686*	*-18.720*	*.000*
\Access to Government Agricultural Subsidy	*.688*	*1.325*	*.189*
Access to Bank Loan.	*.046*	*.169*	*.866*
Membership of Swine Organisation	*.160*	*.485*	*.629*

r = 0.925 R^2 = 0.855 F-cal =110 F-tab $_{(0.05,4,\ 75)}$ = t-tab $_{(0,05,\ 79)}$ =1.98

Dependent Variable; Gross income of Swine Producers in Free State

Source: SPSS 20.0 Output, detail in Appendix 3.

GI = α_o+ α_1 CP + α AGAS + α_1 ABL + α_1 MSO + U_1

Where GI = Gross Income

CP = Cost of Production

AGAS = Access to Government Agricultural Subsidy

ABL = Access to Bank Loan

MSO = Membership of Swine Organization

GI = 0.22 – 1.69CP + 0.69GAS + 0.05ABL + 0.16MSO

t- values (0.28) (-18.72) (1.33) (0.17) (0.49)

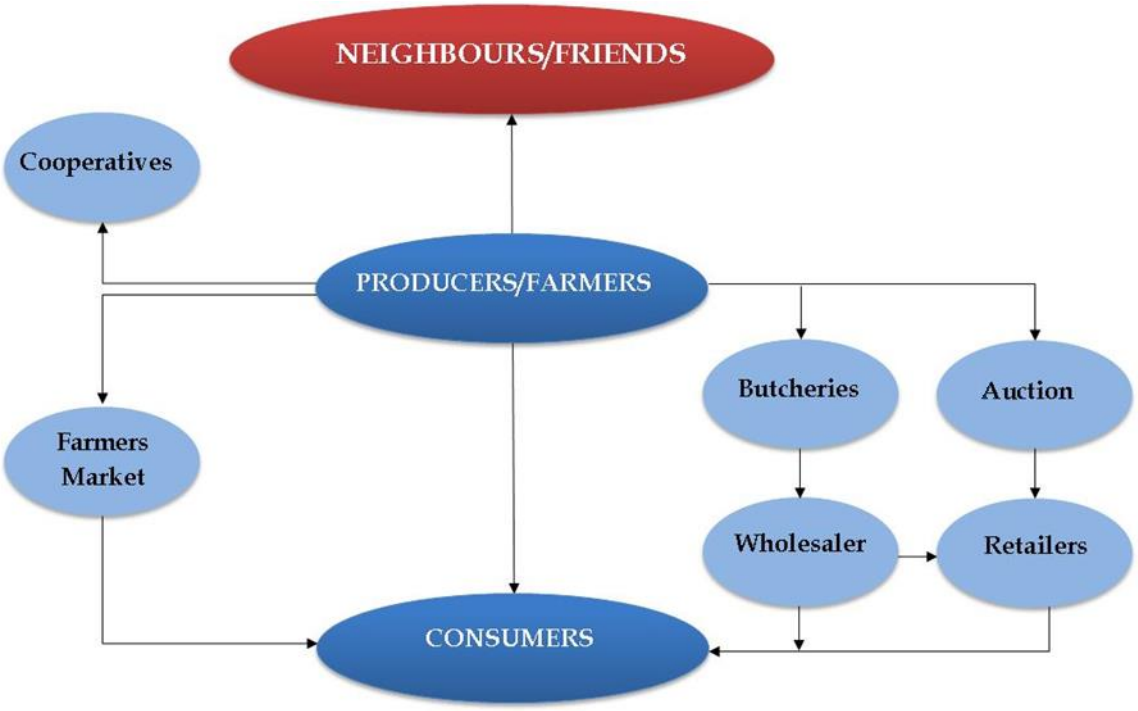
in bracket

The result shows that the Pearson's correlation coefficient is 0.925. This correlation coefficient is very high indicating that a very strong relationship exists between Gross income of Swine Producers in Free State and the determinants. The Coefficient of Determination (R^2) = 0.855. This implies that a 85.5% variation in Gross income of Swine Producers in Free State is explained by variations in Production Cost, Access to Government Agricultural Subsidy, Access to Bank Loan, Membership of Swine Organisation. .The remaining 14.5% is explained by other variables not included in the model. The F-calculated of 110.96 had a corresponding significant F-value

of 0.000 < 0.05 (level of significance); the researcher therefore concludes a good model utility. Conventionally F-cal = 110.96 > F-tab $_{(0.05, 4, 75)}$ = 3.842 hence the above conclusion of a good model utility is upheld.(see Appendix 3).

Figure 7.1 below shows the distribution channel that will assist Free State swine producers maximize their profit.

Fig. 7.1 Proposed Marketing Channel for Swine Producers in Free State Province of South Africa



Source: Researcher's Concept 2015

The concept state that the swine producer can sale the product direct to neighbours/friends/cooperatives/consumers. He can also pass through the butcheries to wholesaler to the retailers and then to the consumers. He can further pass through the auction to the retailer and to the consumers. Finally, he can pass through the farm market to the consumers. This concept reduces cost of long intermediaries for the farmers and thereby increases profit.

References

A profile of the South African Pork Market value Chain (2014). Department of Agriculture, Forestry and Fisheries, Republic of South Africa.

Adhikarya R (1994). Strategic extension campaign: A participatory – oriented method of agricultural extension, Chapter 10 [Online], www.fao.org (Accessed on 18/11/ 2017).

Ahiauzu, A. I. (2007). Developing Africa through capacity building."*Financial Standard,* Monday, January 1.

Ajala, M.K. (2003). Economics of pig production in jama'a local Government Area of Kaduna State, Nigeria.*Tropical Journal of Animal Science* 6(10): 53-62. Published by the Animal Science Association of Nigeria (ASAN). University pf Ibadan.

Alary, V., Corniaux, C. and Gautier, D. (2011). Livestock's Contribution to Poverty Alleviation: How to Measure It? World Development forthcoming.

Alexander, Jennifer (1987). Trade, Traders and Trading in Rural Java Oxford: Oxford University Press

Alexander, Paul. (1993). `What's in a price? Trading Practices in Peasant (and other) Markets', in Roy Dilley (ed.) Contesting Markets: Analyses of Ideology, Discourse and Practice, 79-96. Edinburgh: Edinburgh University Press.

Anderson, D., Ivers, D., Benjamin, M., Gonyou, H., Jones, D., Miller, K., McGuffey, R., Armstrong, T. Mowrey, D., Richardson, L., Seneriz, R., Wagner, J., Watkins, L. and Zimmermann, A. (2002). Physiological Responses of Market Hogs to Different Handling Practices, Proceeding in American Association of Swine Vetinary, Kansas City.

Angier, Natalie (2009). "Pigs prove to be smart, if not vain". The New York Times (New York, New York, US: The New York Times company). http://www.nytimes.com/2009/11/10/sciuence/10angier.html. Retrieved 2014-07-28.

Anon, (2000). Food safety and quality as affected by organic farming, Twenty-Second FAO Regional Conferences for Europe proceedings. Porto, Portugal, July 24–28. 14 p.www.fao.org/docrep/meeting/x4983e.htm

Antwi, M. & Seahlodi, P. (2011). 'Marketing constraints facing emerging small-scale pig farmers in Gauteng province, South Africa', Journal of Human Ecology 36, 37–42.

Ariza-Nino, E.J., Herman L., Makinen, M. and Steedman C. (1980). Livestock and meat marketing in West Africa:1 Synthesis Upper Volta.CRED University of Michigan.

Audsley E., Brander M., Chatterton J., Murphy-Bokern D., Webster C., Williams A. (2009). How low can we go? An assessment of greenhouse gas emissions from the UK food system and the scope to reduce them by 2050.FCRN-WWF-UK.

Averós X, Knowles T, Brown S, Warriss P, Gosálvez L. (2008) Factors affecting the mortality of pigs being transported to slaughter, Vet Rec. 163:386–90.

Avwokeni, A. J. (2006). *Research Methods: Process, Evaluation and critique.* Port Harcourt: Unicenpus Tutorial Services.

Babovic J, Caric M, Djordjevic D and Lazic, S. (2011). Factors influencing the economics of the pork meat production. Agricultural Economics - Czech, (4) 203-209.

Bacharach M. (1977). Economics and the Theory of Games. Westview Press.

Bain J.S., (1969) Industrial organization. 2nd ed. John Wiley and Sons, New York, USA

Becerril-Herrera M, Alonso-Spilsbury M, Trujillo-Ortega M, Guerrero-Legarreta I, Ramirez-Necoechea R, Roldan-Santiago P, (2010). Changes in blood constituents of swine transported for 8 or 16 h to an abattoir. Meat Sci. 86 945–8.

Barney, J.B (2007). Barney on Structure-Conduct-Performance in: Create Advantage Regenerating Enterprises to thrive forever, 54-57 www.createadvantage.com/glossary/structure-conduct-performance baseline findings. J. Nutr.133, 3941S-3949S.

Barton-Gade P, Christensen L, Baltzer M, Petersen L. (2007) Causes of pre-slaughter mortality in Danish slaughter pigs with special emphasis on transport, AnimWelf. 16 459–70.

Bench C, Schaefer A, Faucitano L. (2008) The welfare of pigs during transport. In: Welfare of Pigs: From Birth to Slaughter. Faucitano L, Schaefer AL, editors. Wageningen: Wageningen Academic Publ 161–95.

Bernstein, Henry. (1996). `The Political Economy of the Maize Filière', *Journal of Peasant Studies*, 23(2/3):120-45.

Bester, J. & Küsel, U.S., (1998.) Early domesticated animals in South Africa. Proc. 4th Global Conferenceon Conservation of Domestic Animal Genetic Resources, Nepal.

Bio-Era (Bio Economic Research Associates) (2008). Economic impact of selected infectious diseases. http://www.bio-era.net/reports/biosecurity/bsec_econ_impact.html

Bohannan, Paul and George Dalton. (1965) Markets in Africa. New York: Anchor Books.

Bradshaw R, Hall S, Broom D. (1996) Behavioral and cortisol response of pigs and sheep during transport. *Vet Rec.* 138 233–4

Bradshaw RH, Parrott RF, Forsling ML, Goode JA, Lloyd DM, Rodway RG, (1996) Stress and travel sickness in pigs: effects of road transport on plasma concentration of cortisol, beta-endorphin and lysine vasopressin. *Anim Sci.* 63 507–16.

Brandt P, Aaslyng M. (2015) Welfare measurements of finishing pigs on the day of slaughter: a review, *Meat Sci.* 103 13–23

Branson, E. R., & Norvell, G. D. (1983). Introduction to agricultural marketing. New York, USA: McGraw-Hill, Inc

Briggs, H.M., (1983). International Pig Breed Encyclopedia. Elanco Animal Health, Indianapolis, USA.

Broom, Donald M. Hilana Sena, Kiera L. Moynihan (2009-11). "pigs learn what a mirror image represents and use it to obtgain information". *Animal Behaviour* 78 (5): 1037-1041.

Brown J, Samarakone T, Crowe T, Bergeron R, Widowski T, Correa J, (2011) Temperature and humidity conditions in trucks transporting pigs in two seasons in eastern and western Canada. *Trans Amer Soc AgriBiol Eng.* 54 2311–8.

Brown S, Knowles T, Edwards J, Warriss P. (1999) Relationship between food deprivation before transport and aggression in pigs held in lairage before slaughter. *Vet Rec.* 145 630–364

Brown, R.B. (2006) "Doing Your Dissertation in Business and Management: The Reality of Research and Writing" Sage Publications, p.43.

Bruinsma J. (2003). World agriculture: towards 2015/2030, an FAO perspective. Rome, Italy: Earthscan, FAO.

Brunori G., Jiggins J., Gallardo R., Schmidt O. (2008). The Second SCAR Foresight Exercise, Synthesis Report, 'New challenges for agricultural research: climate change, food security, rural development, agricultural knowledge systems', p. 105 EU Commission Standing Committee on Agricultural Research (SCAR)

Burns, N & Grove, SK. (2012). The practice of nursing research: appraisal, synthesis and generation of evidence. 7th edition St Louis: Elsevier.

Burton R., Mansfield L., Schwarz G., Brown K., Convery I (2005). Social capital in hill farming: report for the Upland Centre. http://www.theuplandcentre.org.uk/pubs.htm .

Butler W. R. (2000) Nutritional interactions with reproductive performance in dairy cattle Animal *Reproduction Science*. 60–61, 449–457.

CAEE 5131 - Agricultural Marketing and Price Analysis: Economic Role of Prices and Approaches to the study of Agricultural Market Organization and Performance, Moi University, Department of Economics and Agricultural Resource Management with support from OER Africa and Bill & Mellinda Gates Foundation Cambridge University pre ss.

Carlisle, K.R.M, and Randag, A.G. (1970). Analysis of factors affecting meat packaging development. In A.H. Bunting (ed). Change in agriculture. Gerald Duck worth & co ltd.London

Chad, P. (2014). Marketing Pigs Pork Information Gateway – U S Pork Center of Excellence 1776Nw114th St. Clive

Chaminuka P, Senyolo GM, Makhura MN (2008). A factor analysis of access to and use of service infrastructure amongst emerging farmers in *South Africa Journal of Agricultural Economics 43(3): 11-12.*

Clutton-Brock, J. (1987). A Natural History of Domesticated Mammals.Cambridge University press, Cambridge pp. 73-74.

Cole DJA, Wiseman J, Marley MA (1994). Principles of Pig Science, Britain: Nottingham University Press.

Conte S, Faucitano L, Bergeron R, Torrey S, Gonyou H, Crowe T, (2015) Effects of season, truck type and location within truck on gastrointestinal tract temperature of market-weight pigs during transport. *Journal of Animal Scence* 93 5840–8.

Correa J, Gonyou H, Torrey S, Widowski T, Bergeron R, Crowe T, (2014) Welfare of pigs being transported over long distances using a pot-belly trailer during winter and summer *Animals* 4 200–13.

Correa J, Torrey A, Devillers N, Laforest J, Gonyou H, Faucitano L. (2010) Effects of different moving devices at loading on stress response and meat quality in pigs. *Journal of Animal Science* 88 4086–93.

Correa JA, Gonyou H, Torrey S, Widowski T, Bergeron R, Crowe T. (2013) Welfare and carcass and meat quality of pigs being transported for 2 hours using two vehicle types during two seasons of the year, *Canadian Journal of Animal Science* 93 43–55.

Cowan, D. (1994). Good Information. Generals Can't Do Without It. Why do CEO's Think They can.*Journal of the Market Research Society* 36(2): 105-114

Creutzig F, Popp A, Plevin R, Luderer G, Minx J, Edenhofer O. (2012). Reconciling top-down and bottom-up modelling on future bioenergy deployment. Nature Climate Change 2, 320 – 327.

DAFF, (2011). A Profile of the South African Pork Market Value Chain, Directorate Marketing.Department of Agriculture, Forestry and Fisheries, RSA.Retrieved March 31, 2014, from www.daff.gov.za/docs/AMCP/Porkmvcp2011-12.

DAFF, 2010. A profile of the South African Beef Market value chain. Directorate: Marketing, Department of Agriculture, Forestry and Fisheries, Pretoria.

Dahlhoff, A. (2002). Assessment of Market Alternatives for Minnesota Meat Export.

Dalgaard T, Hutchings NJ, Porter JR. (2003.) Agroecology, scaling and interdisciplinary *Agriculture, Ecosystems and Environment* 100, 39–51.

DAS, (2010). Abstract of Agricultural Statistics. Compiled by the Directorate of Agricultural

Delgado C. (2005) Rising demand for meat and milk in developing countries: implications for grasslands-based livestock production. In Grassland: a global resource (ed. McGilloway D. A., editor), pp. 29–39, The Netherlands: Wageningen Academic Publishers

Deuffic P., Candau J. (2006). Farming and landscape management: how French farmers are coping with the ecologization of their activities. *Journal of Agricultural Environmental Ethics* 19, 563-585.

Dijkman J. (2009). Innovation capacity and the elusive livestock revolution. LINK News Bulletin, October 2009. www.innovationstudies.orgwww.innovationstudies.org

Dilley, Roy (ed.). (1993). Contesting Markets: Analyses of Ideology, Discourse and Practice. Edinburgh: Edinburgh University Press.

Dietze, K., (2011) 'Pigs for Prosperity', in *Diversification Booklet Number 15*, p. 58, Food and Agriculture Organization of the United Nations, Rome.

Dietze, K., (2011) *Pigs for Prosperity,* Diversification Booklet Number 15, Food and Agriculture Organization of the United Nations, Rome, viewed 25 June 2015, from http://www.fao.org/docrep/015/i2471e/i2471e00.pdf

Dione M, Ouma, E, Roesel K, Mayega L, Nadiope G, Kiryabwire D & Pezo D (2013) Participatory assessment of animal health constraints and husbandry practices in the pig production system in three districts of Uganda. Poster prepared for the 14th International Conference of the Association of Institutions for Tropical Veterinary Medicine (AITVM), Johannesburg, South Africa, 25-29 August 2013. Nairobi, Kenya: ILRI. Factors influencing the economics of the pork meat production. *Agricultural Economics - Czech,* (4): 203-209.

Drucker, A. and Anderson, S. (2004). 'Economic analysis of animal genetic resources and the use of rural appraisal methods: Lessons from Southeast Mexico', *International Journal of Agricultural Sustainability* 2(2), 77-97.

Dumas A., Dijkstra J., France J. (2008). Mathematical modelling in animal nutrition: a centenary review. *J. Agric. Sci.* 146, 123–142.

Dwight R. Sanders, Ira J. Altman, Gary A. Apgar (2012). Determinants of Profitability in Niche Swine Production *Journal of the ASFMRA* 68-77.

Edwards, W.M., G.T. van der Sluis, and E.J. Severer *(1989)*."Determinants of Profitability in Farrow-to-Finish Swine Production."*N. Cent. J. Agr. Econ., 11:17-25.*

Edwards LN, Grandin TA, Engle TE, Porter SP, Ritter MJ, Sosnicki A, (2010) Use of exsanguination blood lactate to assess the quality of preslaughter pig handling *Journal of Meat Science* 86 384–90.

Ellis, M & Ritter, M. (2005a) Impact of Animal Handling and Transportation Conditions on Losses of Slaughter Weight Swine During Transport, Proceeding in American Association of Swine Vetinary, Tronto Canada, 199.

Ellis, M. & Ritter, M. (2005b) Transport Losses: Causes and Solution, Proceeding in Allen D. Leman Swine Conference, St. Paul MN 176.

Ellis, M., McKeith, F., Hamilton, D., Bertol, T., & Ritter, M. (2003) Analysis of the current situation: What do downers cost the industry and what can we do about it? American Meat Science Association Pork Quality Symposium Columbia 1.

Ensminger, Jean. (1992). Making a Market: The institutional transformation of an African society.Cambridge: Cambridge University Press.

Epstein, H. & Masen, I.L., (1971). The Origin of the Domestic Animals of Africa, Volume II. Africana Publishing Corporations, New York.

Evaluating Opportunities in the changing Marketing Environment 123 doc.org>kinh doanh-Tiep thi-Banhang www.fspl.lib.ar.us

Ewert F, van Ittersum MK, Heckelei T, Therond O, Bezlepkina I, Andersen E. (2011). Scale changes and model linking methods for integrated assessment of agri-environmental systems Agriculture, Ecosystems and Environment 142, 6– 17.

FAO (2004). *State of food insecurity in the world, monitoring progress towards the world food summit and Millennium Development Goals,* Food and Agriculture Organization of the United Nations, Rome.

FAO (2007). Global plan of action for animal genetic resources and the Interlaken Declaration.Int. technical conf. on animal genetic resources for food and agriculture, Interlaken, Switzerland, 3–7 September 2007, Rome, Italy: FAO.

FAO (2010) Food and agriculture organization of the United Nations statistical databases. http://faostat.fao.org/

Faucitano L, Goumon S. (2018) Transport of pigs to slaughter and associated handling. In: *Advances in Pig Welfare*. Špinka M, editor. London, Woodhead Publ. 261–93.

Fortin A. (2002) The effect of transport time from the assembly yard to the abattoir and resting time at the abattoir on pork quality. *Can J Anim Sci.* 82141–50

Fox J, Widowski T, Torrey S, Nannoni E, Bergeron R, Gonyou HW, (2014) Water sprinkling market pigs in a stationary trailer. 1. Effects on pig behaviour, gastrointestinal tract temperature and trailer micro-climate. *Livest. Sci.* 160 113–123.

Fubara, B.A. and Mguni, B.S. (2005). *Research Methods in Management,* Port Harcourt, Pear Publishers:50-92.

Galeboe M, Mbaiwa I & Onalenna M (2009) Market study on pig products in Botswana. Research and Development Division, Local Enterprise Authority. Retrieved 10 November 2018 from http://www.lea.co.bw/uploads/files/Piggery%20Study%20Complete%20version.pdf?size=519235

Gandini G. C., Villa E. (2003). Analysis of the cultural value of local livestock breeds: a methodology. *Journal of Animal Breed Genetics* 120, 1-11.

GDACE Gauteng Department of Agriculture, Conservation and Environment (2009). Annual Report.Johannesburg: GDACE.

Gereffi, Gary, Miguel Korzeniewicz and Roberto P. Korzeniewicz. (1994). "Introduction: Global Commodity Chains," in Gereffi, Gary and Miguel Korzeniewicz (eds.), Commodity Chains and Global Capitalism, pp. 1-14, Westport, CT: Greenwood Press.

Ghatak, S. and Intersent, K. (1984). Agriculture and Economic Development. Brighton: Wheatsheaf Book Ltd.

Giuffra E; Kijas, JM; Amarge, V; Carborg, O; Jeon, JT; Andersson, L. (2000). "The origin of the domestic pig: independent domestication and subsequent introgression". *Genetics* 154(4):1785-91.

Gosálvez L, Averós X, Valdelvira J, Herranz A. (2006) Influence of season, distance and mixed loads on the physical and carcass integrity of pigs transported to slaughter. *Meat Sci.* 73 553–8

Goumon S, Brown J, Faucitano L, Bergeron R, Widowski T, Crowe T, (2013) Effects of transport duration on maintenance behavior, heart rate and gastrointestinal tract temperature of market-weight pigs in 2 seasons *Journal of Animal Science* 91 4925–35.

Goumon S, Faucitano L, Bergeron R, Crowe T, Connor M, Gonyou H. (2013) Effect of ramp configuration on easiness of handling, heart rate and behavior of near-market pigs at unloading, J *Anim Sci.* 91 3889–98

Goumon S, Faucitano L. (2017) Influence of loading handling and facilities on the subsequent response to pre-slaughter stress in pigs. *Livest Sci.* 200 6–13.

Grandin T. (1994) Farm animal welfare during handling, transport, and slaughter. *J Amer Vet Med Assoc.* 204 372-7.

Granovetter, Mark. (1985). `Economic Action and Social Structure: The Problem of Embeddedness', *American Journal of Sociology,* (91)3: 481-510.

Gura S. (2008). Industrial livestock production and its impact on smallholders in developing countries. Consultancy report to the League for Pastoral Peoples and Endogenous Livestock Development, Germany. http://www.pastoralpeoples.org .

Haley C, Dewey C, Widowski T, Friendship R. (2008) Association between in-transit losses, internal trailer temperature, and distance travelled by Ontario market hogs. *Can J Vet Res.* 72 385-9.

Halimani, T. E., Phitsane, P.M., Mtileni, B. J., Muchadeyi, F. C., Chimonyo, M., and Dzama, K. (2008). Factors Influencing Herd Size, Breed Preference and Production System of Genetic Resources from Smallholder Farmers in South Africa. Proceedings of the 10th World Congress on Animal Production, 23-28 November 2008, South Africa.

Hare, E., Norman H. D. and Wright J. R. (2006). Trends in calving ages and calving intervals for dairy cattle breeds in the United States. *J. Dairy Sci.* 89, 365-370.

Harriss, B. (1984). State and market: State Intervention in Agricultural Exchange in Dry region of Tamil Nadu, South India, New Delhi Concept Publishing Company.

Hayes B. J., Bowman P. J., Chamberlain A. J., Goddard M. E. (2009). Genomic selection in dairy cattle: progress and challenges. *J. Dairy Sci.* 92, 433–443.

Heady, E.O., and H.R. Jensen (1954). *Farm Management Economics* New York: Prentice-Hall.

Hewitt de Alcantara, Cynthia (ed.). (1993). Real Markets: Social and Political Issues of Food Policy Reform. London: Frank Cass.

Hill, P (1970). Studies in rural capitalism in West Africa Cambridge University press.

Holness, D.H. (1991). The Tropical Agriculturalist-Pigs Wageningen, Netherlands Macmillan Education Limited.

Ikanni I & Dafwang I (1995) Pig production technology for pig farmers. *National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria.* 25(1) 74.

Integrated Sustainable Rural Development Strategy (ISRDS) (2004). South Africa, a Better Place to Live in. Retrieved on December 14, 2013, from http://www.info.gov.za/oth-erdocs/isrds.pdf.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate Change 2007: impacts, adaptation and vulnerability. Summary for policy makers. http://www.ipcc.ch/publications_and_data/ar4/wg2/en/spm.html

Irekhore O & Olutemi S (2012) General overview of pig production, enterprise selection and establishment. Pig production training manual. Agricultural Media Resources and Extension Centre.41

Ironkwe, M. & Amefule, K. (2008) 'Appraisal of indigenous pig production and management practices in Rivers State, Nigeria', *Journal of Agriculture and Social Research* 8, 1–7.

Ittner, C.D., and Larcker, D. (2003). Coming up short on nonfinancial performance measurement. *HarvardBusiness Review*, pp. 1–8.

Jarvis, L. S (1980). Cattle as a store of wealth in Swaziland: Comment *American Journal of Agriculture and Economic* 62(3): 606-613.

Jean Paul Rodrigue (2013). Commodity Chain Analysis Department of Global Studies and Geography,Hofstra University, New York USA.

Jesse C. Ribot, (2005). Policy and Distributional Equity in Natural Resource Commodity Markets: Commodity-Chain Analysis as a Policy Tool Institutions and Governance Program World Resources Institute 10 G Street, NE, Suite 800 Washington.

Jones, G.E. Garforth (1994). Improving Agricultural Extension: The History, Development and Future of Agricultural Extension, Chapter 1 [Online], http: //www.fao.org (Accessed on 18/11/2015).

Joseph L. Bower and Clayton M. Christensen, (1995). "Disruptive Technologies: Catching the Wave,"HBR January–February 1995.

Kemm EH. (1993). Pig Production in South Africa, *Agricultural Research Council (ARC) Bulleting, 427. Pretoria: V and R Printers.*

Khalifa, A. H and Simpson, M.C. (1972). Perverse supply in nomadic societies. *Oxford Agrar. Stud.* 1: 47-56.

Karaimu P (2014) Pig farming in Uganda, Big options and big research, take hold. Better lives through livestock, science for a food secure future. International Livestock Research Institute, Nairobi.

Khem R, Pinsun L & Zaleski M (1997) Economic analysis of size and feed type of swine production in Hawaii. *Swine Health and Production,* 5(3) 103–110.

Kiers E. T., Leakey R. R. B., Izac A.-M., Heinemann J. A., Rosenthal E., Nathan D., Jiggins J. (2005). Agriculture at a crossroads. *Science* 320, 320–321

King D. A., Peckham C., Waage J. K., Brownlie J., Woolhouse M. E. J. (2006*b)*. Infectious diseases: preparing for the future. Science 313, 1392–1393 (doi:10.1126/science.1129134).

King J. M., Parsons D. J., Turnpenny J. R., Nyangaga J., Bakara P., Wathes C. M. (2006*a)*. Modelling energy metabolism of Friesians in Kenya smallholdings shows how heat stress and energy deficit constrain milk yield and cow replacement rate. *Anim. Sci.* 82, 705–716

Kitalyi A., Mtenga L., Morton J. U., McLeod A., Thornton P., Dorward A., Saadullah M. (2005). Why keep livestock if you are poor? In Livestock and wealth creation: improving the husbandry of animals kept by resource-poor people in developing countries (eds Owen E., Kitalyi A., Jayasuriay N., Smith T.,editors), pp. 13–27 Nottingham, UK: Nottingham University Press.

Klober, K. (2001). Promoting value-added pork.U.S.A. October. P. 14.

Klober, Kelly. (1998). Approaches to marketing—Notes from a direct sales survivor. Small Farm Today October-November, p. 48-51.

Kohls RL, Uhls JN (2002). Marketing of Agricultural Products, New Jersey: Prentice Hall Inc.

Kong, Q, Zhao, L, Sun, S., Wang, X and Zhang, M. (2009). Safety Control Mewat Supply Chain: A Case Study of SUTAI pigs. Innovative Computing, Information and Control (ICICIC), 2009 Fourth International conference on 7-9 Dec. 2009, page(s): 709-712.

Kotler, Armstrong, Philip, Gary (2006). *Principles of Marketing.* Pearson education. (Version 12/E). Inc. New Jersey.

Kristjanson, P., Krishna A., Radeny M. and Nindo W. (2004). Pathways out of poverty in western Kenya and the role of livestock. PPLPI Working Paper No. 14 Rome, Italy: FAO.

Kugonza D, Kirembe G, Tomusange-Nvule E, Lutalo D & Drani E (2012). Experimental validation of farmer innovations in incubation and brooding management of chickens. *Livestock Research for Rural Development, 24(91)*. Retrieved February 24, 2016, from http://www.lrrd.org/lrrd24/5/kugo24091.htm

Kugonza D, Lubandi C, Kirembe G, Taabu H & Lusembo P (2015) Effect of genotype and post-weaning diet in enhancing pig production within Lake Victoria crescent in Uganda. *Agricultural Innovations for Sustainable Development,* 4(3) 296–304.

Kugonza D, Nabasirye M, Hanotte O, Mpairwe D & Okeyo A (2012). Pastoralists' indigenous selection criteria and other breeding practices of the long-horned Ankole cattle in Uganda, *Tropical Animal Health and Production,* 44(3) 557–565.

Kwon, Oh-Chul, Kim, Jin-Seong, Kim, Pan-Jun, Kim, Pan-Jin, Kim, Hong-Seop, Namkung, Suk, Park, Yeung-Kurn, Park, Chul-Ju, Park, Hyoung-Jin, Youn, Myoung-Kil, Lee, Jang-Hwan, Hwang, Hwa-Chul, & Kim, Yoo-Oh. (2007). A Note on the Unification on Retail Trade T terminology *Journalof Distribution Science*, 5 (2): 5-16.

Kyriazakis, I. and Whittemore, C.T. (2006). Whittemore's Science and Practise of Pig Production (3rd ed.). UK: Oxford, Blackwell Publishing Ltd.

Laborte, A.G., van Ittersum M.K. and van den Berg M.M. (2007). Multi-scale analysis of agricultural development: A modelling approach for Ilocos Norte, Philippines. *Agricultural Systems*94, 862-873.

Lambert, C. and M.B. Sands. (1984). *Kansas Steer Futurities: Summary of Nine Years of Retained Ownership.* Kansas State University Cooperative Extension Service MF-712.

Lambooij E. (2014) Transport of pigs. In: *Livestock Handling and Transport*, Grandin T, editor. Wallingford: CABI Publisher 280–297.

Langemeier, M.R (1992). "Cattle Finishing Budgets and Returns" In *Ag. Update: Monthly Marketing/Farm Mgt. Newsletter.* Kansas State University Cooperative Extension Service,January 23, 1992.

Langyintuo, A., S., and Mungoma, C. (2006). The Effect of Household Wealth on Input Market Participation in Southern Africa. Proceedings of the 26th Conference of the International Association of Agricultural Economist, 12-18 August, Gold Coast Convention Centre, Queensland, Australia Retrieved January 23, 2014, from http://ageconsearch.umn.edu/bitstream/25630/1/cp06119.pd f.

Lawrence A.B. (2008). Applied animal behaviour science: past, present and future prospects. *Appl. Anim.Behav.* Sci. 115, 1–24.

Lawrence, A.B. (2009). What is Animal Welfare? Fish welfare (ed. Branson E., editor). Oxford, UK: Blackwell.

Lawrence, A.B., Conington, J. and Simm, G. (2004) Breeding and animal welfare: practical and theoretical advantages of multi-trait selection. Anim. Welfare 13, S191–S196.

Lawrence, A.B. and Stott, A.W. (2009). Profiting from animal welfare: an animal-based perspective. Oxford Farming Conf. 2009.

Leakey R., et al. (2009). Impacts of AKST (Agricultural Knowledge Science and Technology) on development and sustainability goals. In Agriculture at a crossroads (eds McIntyre B. D., Herren H. R., Wakhungu J., Watson R. T., editors. 145–253 Washington, DC: Island Press.

Lewin H. A. (2009). It's a bull's market. Science 323: 478–479

Livestock and poultry: World Markets and Trade. "Circular Series DL&P 2-06, Foreign Agricultural Service, United States Department of Agriculture, October 2006. Retrieved on 2015- 08-15.

Low, A.R.C., Kemp, R.L. and Doran, M.H. (1980). Cattle as a store of wealth: *American Journal of Agriculture and economic* 62(3): 613-617.

Lush, J. L (1994). The Genetics of Population: Iowa Agricultural and Home Economics experiment Station, College of Agriculture, Iowa State University, Ames.

MA (2005). The millennium ecosystem assessment, ecosystems and human well-being: scenarios, vol. 2 Washington, DC: Island Press.

Mac'Odo, D.S. (2002). Statistics for Decision-making: Port Harcourt; Pearl Published Ltd.

Mackingtosh, M. (1990). Abstract Markets and Real Needs in Henry Bernstern, Ben Crow.

Maddison A. (2003). The world economy: historical statistics. Paris, France: OECD.

Madzimure, J., Chimonyo, M., Zander, K. K., and Dzama, K. (2012a). Potential for Using Indigenous Pigs in Subsistence-Oriented and Market-Oriented Small-Scale Farming Systems of Southern Africa. *Tropical Animal Health and Production,* 45: 135-142.

Mahabile, M., Lyne, M., & Panin, A. (2002). Factors Affecting the Productivity of Communal and Private Livestock Farmers in Southern Botswana: A Descriptive Analysis of Sample Survey Results. Agrekon, 41(4): 326-338

Makiwane, M., Makoae, M., Botsis, H. & Vawda, M., (2012) A baseline study on families in Mpumalanga, Human Sciences Research Council, Pretoria: Human and Social Development, Population Health, Health Systems and Innovation, CeSTii, viewed 02 July 2015, from file:///C:/Users/user/Downloads/Mpumalanga%20family%20study%2030-07-2012.pdf

Marsh, J.M. (1985). "Monthly Price Premiums and Discounts Between Steer Calves and Yearlings."*Am. J.Agr. Econ.,* 67: 307-314.

McDonald, J.H. (2003). Handbook of Biological Statistics; Baltimore, Maryland: Sparky House publishing; pages 1-28.

McIntire J., Bourzat D. and Pingali P. (1992). Crop-livestock interactions in sub-Saharan Africa. Washington, DC: World Bank

McMillan, J.H., and Schumacher, S. 2001. Research in Education: A Conceptual Introduction (5th ed.). New York, NY: Longman.

Meissner, H.H., Scholtz, M.M., and Palmer, A.R. (2013). Sustainability of the South African Livestock Sector towards 2050 Part 1: Worth and impact of the sector. South African Journal of Animal Science 43 (3): 282-297.

McGlone J, Johnson A, Sapkota A, Kephart R. (2014) Establishing trailer ventilation (boarding) requirements for finishing pigs during transport. *Animals* 4 515-23.

Mergenthaler, M., Weinberger, K. & Qaim, M., (2009) 'The food system transformation in developing countries: A disaggregate demand analysis for fruits and vegetables in Vietnam', *Food Policy* 34, 426–436. http://dx.doi.org/10.1016/j. foodpol.2009.03.009

Mhlanga, F., (2002) *Community-based management of animal genetic resources: A participatory approaches framework,* viewed 25 June 2015, from https://cgspace.cgiar.org/bitstream/handle/10568/3690/mhlanga.pdf?sequenc=1

Mhlanga, F. N. (2002). Community-based management of Animal Genetic Resources: A Participatory Approaches Framework. Harare, Zimbabwe: Department of Animal Science, University of Zimbabwe.

Mokoele, J., Janse van Rensburg, L., Van Lochem, S., Bodenstein, H., Du Plessis, J., Carrington, CP, *(*2015) Overview of the perceived risk of transboundary pig diseases in South Africa, *Journal of the South African Veterinary Association* 86(1),

Moll, H.A.J., Staal, S. and Ibrahim, M.N.M. (2007). Smallholder dairyproduction and markets: A comparison of production systems in Zambia, Kenya and Sri.

MPG, 2013, *Socio-economic review and outlook of Mpumalanga - June 2013,* viewed 04 July 2019.

Mota-Rojas D, Becerril M, Lemus C, Sánchez P, González M, Olmos S, (2006) Effects of mid-summer transport duration on pre- and post-slaughter performance and pork quality in Mexico, *Meat Sci.* 73 404–12.

Muhanguzi D, Lutwama V and Mwine F (2012) Factors that influence pig production in central Uganda - A case study of Nangabo sub-county, Wakiso District. Veterinary World, 5(6): 334–351.

Muys D & Westernbrink G (2004) Pig Keeping in the Tropics. Agromisa Foundation, Wageningen Journey to forever. 81.

Mwangulu, J. A. (2014). Factors Influencing Marketing of Alcoholic Beverages in KenyaEuropean *Journal of Business and Social Sciences,* 3(2): 122-153.

NAADS (National Agricultural Advisory Services), (2011) User guide on pig husbandry. Ministry of Agriculture Animal Industry and Fisheries, Entebbe.

Nannoni E, Liuzzo G, Serraino A, Giacometti F, Martelli G, Sardi L, (2016) Evaluation of pre-slaughter losses of Italian heavy pigs. *Anim Prod Sci*. 57 2072–81.

Neumann, C. G. (2003). Animal source foods improve dietary quality, micronutrient status, growth and cognitive function in Kenyan school children: background, study design and baseline findings. *Journal of Nutrition* 133, 3941S–3949S.

Nicole Crampton, (2015). Grants, funding and incentives for agriculture in South Africa: A comprehensive guide to government grants, funding and incentives for the agriculture sector.

Norton, G.W., Alwang, J. and Masters, W.A. (2006). The Economics of Agricultural Development: World Food System and Resource Use, New York: Routledge. http: // www.syngenta foundation.org/index.cfm percent (Accessed on 20/11/2017).

NRC (National Research Council). (2009). Emerging technologies to benefit farmers in sub-Saharan Africa and South Asia. Washington, DC: National Academies Press.

Ogunsumi, L.O. (2007). Socio-economic Conditions of Peasant Farmers: The Case of Agricultural Technologies' Sustainability in Southwest Nigeria, *Journal of Agricultural Economics, 2(29): 441-446.*

Ohlmann, J. and Jones, P. (2008). An integer programming model for optimal pork marketing. Annals of Operations Research, 1–17- DOI: 10.1007/s10479-008-0466-3.

Otte, J., Roland-Holst, D., Pfeiffer, D., Soares-Magalhaes, R., J., Graham, J. and Silbergeld, E. (2007). Industrial livestock production and global health risks. Pro-Poor Livestock Policy Initiative Research Report Rome, Italy: FAO.

Otte, J. and Upton, M. (2005). Poverty and livestock agriculture. WAAP Book of the Year 2005, 281-296. The Netherlands: Wageningen Academic Publishers.

Ouma E, Dione M, Lule P, Rosel K & Pezo D (2013) Characterization of smallholder pig production systems in Uganda. Constraints and opportunities for engaging with market systems. *International Livestock Research Institute.* 87.

Pérez M, Palacio J, Santolaria M, Aceña M, Chacón G, Gascón M, (2002) Effect of transport time on welfare and meat quality in pigs, *Meat Sci.* 61 425–33.

Pica-Ciamarra U, Baker D, Morgan N, Zezza A, Azzarri C, Nsiima L, Nouala S, Okello P & Sserugga J (2015) Investing in the livestock sector – why good numbers matter. A source book for decision makers on how to improve livestock data. The World Bank/FAO/ILRI/AU-IBAR/BMGF.132

Pandey, M. and Tewari, D, (2004), Rural and Agricultural Marketing: Opportunities, Challenges and Business Strategies. Delhi: International Book Distributing Co.

Parker, D.C., Manson, S.M., Janssen, M.A., Hoffmann, M.J. and Deadman, P. (2003). Multi-agent systems for the simulation of land-use and land-cover change: A review. *Annals of the Association of American Geographers* 93: 314-337.

Paul, J.L. (2008). Encyclopedia of Research Methods SAGE Publication India 1 & 2.

Peden, D., Tadesse, G. and Misra, A.K. (2007). Water and livestock for human development. In Water for food, water for life: a comprehensive assessment of water management in agriculture, ch. 13 (ed. Molden D.), London, UK: Earthscan; Colombo: IWMI.

Perry, B. and Sones, K. (2009) Global livestock disease dynamics over the last quarter century: drivers, impacts and implications. Rome, Italy: FAO; (Background paper for the SOFA 2009).

Philip, K. Thornton (2010). Livestock production: recent trends, future prospects Philos Trans R Soc Lond B Biol Sci. 2010 Sep 27; 365(1554): 2853–2867.

Platteau, Jean-Philippe. (1996). `The Evolutionary Theory of Land Rights as Applied to Sub-Saharan Africa: A critical assessment', *Development and Change* (27): 29-86.

Plug, I. and Badenhorst, S. (2001). The distribution of micromammals in Southern Africa over the past 30,000 years. Transvaal Museum Monograph 113, South Africa.

Porter, M E. (1980). Competitive Strategy. New York: Free Press.

Prolit, A.Z. (2004). Pig Farming Project Literacy Productions, Cape Town, South Africa.

Quin, P.J. (1959). Foods and Feeding Habits of the Pedi. Witwatersrand University Press, Johannesburg, South Africa.

Raloff, J. (2003). Food for Thought: Global Food Trend. Science News Online. May 31, 2003.

Re, P. Aspetti (2000). finanziari e quantitativi del Marketing. Turin (IT): Giappichelli.

Reid, R.S., et al. (2008). Fragmentation of a peri-urban savannah, Athi-Kaputiei Plains, Kenya. In Fragmentation in semi-arid and arid landscapes (eds Galvin K. A., Reid R. S., Behnke R. H., Hobbs N. T., editors.), pp. 195–234 Dordrecht, The Netherlands: Springer.

Ribot, Jesse C. (1990). `Markets, States and Environmental Policy: The Political Economy of Charcoal in Senegal'.PhD Dissertation, University of California.

Ritter MJ, Ellis M, Berry NL, Curtis SE, Anil L, Berg E, (2009) Transport losses in market weight pigs: a review of definitions, incidence, and economic impact. *Prof Anim Sci.* 25 404–14.

Ritter MJ, Ellis M, Bowman R, Brinkmann J, Curtis SE, DeDecker JM, (2008) Effects of season and distance moved during loading on transport losses of market-weight pigs in two commercially available types of trailer. *J Anim Sci.* 86 3137–45.

Ritter, M., Ellis, M., Benjamin, M., Berg, E., Dubois, P., Marchan-Ford, J., Green, A., Matzat, P., Mormede, P., Moyer, T., Pfalzgrat, K., Siemens, M., Sterle, J., Whitney, T., Wolter, B & Johnson, A (2005) The fatigued Pig syndrome, *Journal of Animal Science* 83 (1) 258 (Abstract)

Roelofse, J.., (2013) 'Economic feasibility study of the establishment of smallholder pig farmers for the commercial market: Empolweni case study', Master of Industrial Engineering dissertation, Stellenbosch University.

Rodell, M., Velicogna I., and Famiglietti J.S. (2009). Satellite-based estimates of groundwater depletion in India. Nature460, 999-1002.

Rosegrant, M.W., Cai X. and Cline, S. A. (2002). Global water outlook to 2025, averting an impending crisis. A 2020 vision for food, agriculture, and the environment initiative. Washington, DC: IFPRI and IWMI.

Rosegrant, M.W., Fernandez, M., Sinha, A., Alder, J., Ahammad, H., de Fraiture, Charlotte ,Eickhour, B.; Fonseca, J., Huang, J., Koyama, O., Omezzine, A.M., Pingali, P., Ramirez, R., Ringler, C., Robinson, S., Thornton, P., van Vuuren, D. and Yana-Shapiro, H. (2009). Looking into thefuture for agriculture and AKS in McIntyre, B. D.; Herren, H. R.; Wakhungu, J.; Watson, R. T. (Eds.). International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD): Agriculture at a Crossroads, global report. Washington, DC, USA: Island Press. pp.307-376.

Rounsevell, M.D.A., Pedroli, B., Erb, K.H. Gramberger, M, Busck, A.G., Haberl, H., Kristensen, S., Kuemmerle, T., Lavorel, S., Lindner, M., Lotze-Campen, H., Metzger, M.J., Murray-Rust,

D., Popp, A., Pérez-Soba, M., Reenberg, A., Vadineanu, A., Verburg, P.H. and Wolfslehne B. (2012). Challenges forland system science. Land Use Policy 29, 899-910.

Rufino, M.C., Dury, J., Tittonell, P., van Wijk, M.T., Herrero, M., Zingore, S., Mapfumo, P. and Giller, K.E. (2011). Competing use of organic resources, village-level interactions between farm types and climate variability in a communal area of NE Zimbabwe. Agricultural Systems 104, 175-190.

Ruvinsky, A. and Rothschild, M.F. (1998). Systematics and phylogeny of pigs. In: The Genetics of the Pig. Eds Rothschild, M.F. & Ruvinsky, A., CAB International, UK. pp. 1-16.

Salmi B, Trefan L, Bünger L, Doeschl-Wilson A, Bidanel J, Terlouw C, (2012) Bayesian meta-analysis of the effect of fasting, transport and lairage times on four attributes of pork meat quality. *Meat Sci.* 90 584–98

SAPPO. (2011). South Africa Pork Producers' Organisation. Retrieved April 3, 2014, from http://www.sapork.biz/about-sappo/.

SAPPO, (2006) Future competiveness of the pork industry, http//www.sapork.com.

Sarah, M. Nelson. (1998). Ancestors for the pigs. Pigs in prehistory.

Schinckel, A.P., N. Li, P.V. Preckel, and M. Einstein. (2003b). Development of a Model to Describe the Compositional Growth and Dietary Lysine Requirements of Pigs Fed Ractopamine *Journal of Animal Science.*

Schmalensee, R. (1989). Inter-industry studies of structure and performance. In: Schmalensee R, Willig R (eds) Handbook of industrial organization, (2). North-Holland, Amsterdam, 951-1009.

Schofield, P. (2007). Portable image-based pig weight monitoring systems. In: 3rd European Conference on Precision Livestock Farming. Skiathos, Greece.

Schonfeld, H. (2001). Consumer trends in South Africa with reference to meat and pork. Lecture presented at the Mini Symposium the role of pork in the new Millenniuim.ARC-Irene. Tuesday 20 February, 2001.

Scheeren M, Gonyou H, Brown J, Weschenfelder A, Faucitano L. (2014) Effect of transport time and location within truck on skin bruises and meat quality of market weight pigs in two seasons. *Can J Anim Sci.* 94 71–8

Sharma K, Leung P, & Zaleski H (1997) Economic analysis of size and feed type of swine production in Hawaii. Swine Health and Production, 5: 103–110.

Shubik, M. (1972). On Gaming and Game Theory. Management Science, 5(5): 37-53.

Silverman, Aaron. (2003). Selling meat at market. Growing for Market. April. P.1, 4-6. Southwest State University, Marshall, Minnesota. Project funded by Agricultural Utilization

Research Institute. p.www.auri.org/research/meatexport/pdfs/meateexport.pdf (PDF/186KB).

Simm, G. (1998). Genetic improvement of cattle and sheep. Wallingford, UK: CABI Publishing.

Simm, G., Bünger, L., Villanueva, B. and Hill, W.G. (2004). Limits to yield of farm species: genetic improvement of livestock. In Yields of farmed species: constraints and opportunities in the 21st century (Sylvester-Bradley R., Wiseman J., editors.), pp. 123–141 Nottingham, UK: Nottingham University Press.

Singh, K. (2007). "Quantitative Social Research Methods" SAGE Publications, p.64.

Smith, C. (1984). Rates of genetic change in farm livestock. Res. Dev. Agric. 1: 79–85.

Sommavilla R, Faucitano L, Gonyou H, Seddon Y, Bergeron R, Widowski T, (2017). Season, transport duration and trailer compartment effects on blood stress indicators in pigs: relationship to environmental, behavioural and other physiological factors, and pork quality traits. *Animal* 7 8

Stephens D, Perry G. (1990) The effects of restraint, handling, simulated and real transport in the pig (with reference to man and other species). *ApplAnimBehav Sci.* 28 41–55.

Speiser B. (2008) Nano-particles in organic production? Issues and opinions. Paper presented at 16th IFOAM Organic World Congress, Modena, Italy, 18–20 June 2008.

Statistics, Department of Agriculture, Forestry and Fisheries, South Africa. http://www.daff.gov.za/

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and de Haan C. (2006). Livestock's long shadow: environmental issues and options. Rome, Italy: FAO.

Straatman, B, Marceau, D.J. and White, R. (2013). A Generic Framework for a Combined Agent-based Market and Production Model. Computational Economics 41, 425-445.

Steven, J.M. and Francisco, L.C. (2004). Overview of World Swine and Pork Production, Agricultural Science 1.

Sutherland M, Bryer P, Davis B, Smith J, McGlone J. (2012) The combined effects of transport and food and water deprivation on the physiology of breeding gilts, *Livest Sci.* 144 124–31

Sutherland MA, McDonald A, McGlone JJ. (2009) Effect of variations in the environment, length of journey and type of trailer on the mortality and morbidity of pigs being transported to slaughter. *Vet Rec.* 165 13–8

Swanson, E.R. (1959) "Sources of Profit and Decision Making in Cattle Feeding."*J. Farm Econ.,* 41:640-644.

Swanson, E.R., and West, V.I. (1963). "Statistical Analysis of Feeder Cattle Returns." 1. *Farm Econ.,* 45: 146-150.

Tallec, F. and Bockel, L. (2005). "Commodity Chain Analysis: Constructing the Value Chain, Functional Analysis and Flow Charts," Prepared for the Food and Agriculture Organization of the United Nations, FAO.

Tarrant PV. (1989) The effects of handling, transport, slaughter and chilling on meat quality and yield in pigs - a review, *Irish J Food Sci Tech.* 13 79–107

Tatwangire A (2013) Successes and failures of institutional innovations to improve access to services, input and output markets for small holder pig production systems and value chains in Uganda. More meat, milk fish by and for the poor, research program on livestock and fish. ILRI, Nairobi. 65 pp.

The Changing Marketing Environment highered.mheducation.com

Thornton, P.K., Jones, P.G., Owiyo, T., Kruska, R.L., Herrero, M., Kristjanson, P., Notenbaert, A., Bekele, N,, Omolo, A., Orindi, V., Ochieng, A., Otiende, B., Bhadwal, S., Anantram, K., Nair, S., Kumar, V. and Kelkar, U. (2006) Mapping climate vulnerability and poverty in Africa. Report to the Department for International Development, ILRI, Nairobi, Kenya. http://www.dfid.gov.uk/research/mapping-climate.pdf

Torrey S, Bergeron R, Faucitano L, Widowski T, Lewis N, Crowe T, (2013) Transportation of market-weight pigs: 2. Effect of season and animal location in the truck on behavior with an 8-hour transport. *J Anim Sci.* 91 2872–78.

Torrey S, Bergeron R, Gonyou HW, Widowski T, Lewis N, Crowe T, (2013) Transportation of market-weight pigs: 1. Effect of season and truck type on behavior with a 2-hour transport. *J Anim Sci.* 91 2863–71.

Torrallardona, D. and Roura, E. (2009). Voluntary feed intake in pigs. Wageningen Academic

Treacy, D.A. (1976). A genetic analysis of the pedigree Landrace pig breed in Australia. *Aust. J. Exp. Agric. Anim. Husband.* 16, 76-81.

Trochim, W. (2006). The Research Methods Knowledge Base, 2nd ed. Gucinnati, Atomic Dog Pub. 385-410.

Towne, C.W. and Wentworth, E.N. (1950) Pigs from Cave to Cornbelt. University of Oklahoma Press. Norman, Oklahoma. 305

Tullock, G. (1987). Adam Smith and the Prisoner's Dilemma, *Quarterly Journal of Economics* May, 179-221.

Turner, S.P., Horgan, G.W., Edwards, S.A. (2003). Assessment of sub-grouping behaviour in pigs housed at different group sizes. Appl. Anim. Behav. Sci. 83, 291-302.

Tuyen, D. K., Lich, L. B., & Trivedi, K. R. (1998). Livestock Production Situation in Vietnam and Development Orientation. International Workshop on Animal Recording for Smallholders in Developing Countries, October 20-23, India.

UNFCCC (United Nations Framework Convention on Climate Change). (2008). Challenges and opportunities for mitigation in the agricultural sector: technical paper. United Nation Framework Convention on Climate Change.

UNFPA (United Nations Population Fund). (2008). The State of World Population 2007: unleashing the potential of urban growth. United Nations Population Fund. http://www.unfpa.org/swp/swpmain.htm

UNPD (United Nations Population Division). (2008). The 2006 revision and world urbanization prospects: the 2005 Revision. Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects. http://esa.un.org/unpp

Valdivia, R.O., Antle, J.M., Stoorvogel, J.J. (2012). Coupling the Tradeoff Analysis Model with a market equilibrium model to analyze economic and environmental outcomes of agricultural production systems. Agricultural Systems 110, 17-29.

Vallat, B., Acar, J.F., Schudel, A. (2005). Antibiotic use in animal production and consequences on food safety. The Netherlands: Wageningen Academic Publishers; (WAAP Book of the Year 2005, 311–317).

Van Dijk, J., Sargison ,N.D., Kenyon, F., Skuce, P.J. (2010). Climate change and infectious disease: helminthological challenges to farmed ruminants in temperate regions. *Animal* 4, 377–392

Van Vuuren D. P., (2009) Outlook on agricultural change and its drivers. In Agriculture at a crossroads (eds McIntyre B. D., Herren H. R., Wakhungu J., Watson R. T., editors), 255–305 Washington, DC: Island Press.

Vink, N. and Kirsten, J. (2000). Deregulation of Agricultural Marketing in South Africa. The Free Market Foundation. www.freemarketfoundation.com/htmuploa. (Accessed on 21/1/2016).

Visser, D.P. (2004). Structuring of breeding objectives in the pork supply chain in South Africa, unpublished Doctoral Thesis, University of Pretoria, Pretoria.

Visser, D.P., Browne, A. and Botes, F. DuT. (1993). Breeds and breeding programs. In: Pig Production in South Africa. Ed. Kemm, E.H., Agricultural Research Council. V & R Printers, Pretoria. pp. 19-20.

Vitali A, Lana E, Amadori M, Bernabucci U, Nardone A, Lacetera N. (2014) Analysis of factors associated with mortality of heavy slaughter pigs during transport and lairage, *J Anim Sci.* 92 5134–41.

Wedel, M. 2002. Introduction to the Special Issue on Market Segmentation. Intern. J. of Research in Marketing 19: 181-183.

Weimar, M.R, and Hallam, A. (1990*)*. "Risk Sharing in Custom Cattle Feeding." *N. Cent.J. Agr. Econ. 12: 279*-291.

Weitz, B. e Wang Q. (2004). Vertical relationships in distribution channels: a marketing perspective. The Anti-Trust Bulletin, 49: 859-876.

Wheeler, M.B. (2007). Agricultural applications for transgenic livestock. Trends Biotechnol. 25: 204–210. Cross Ref Medline Web of Science.

Wagner, H. M. (1985). Principles of Operations Research. NJ (USA) Prentice Hall.

Werner C, Reiners K, Wicke M. (2007) Short as well as long transport duration can affect the welfare of slaughter pigs, *Animal Welfare.* 16 385-9.

Warriss P. (1998) The welfare of slaughter pigs during transport. *AnimWelf.* 7 365-81.

Weschenfelder A, Torrey S, Devillers N, Crowe T, Bassols A, Saco Y, (2012) Effects of trailer design on animal welfare parameters and carcass and meat quality of three Pietrain crosses being transported over a long distance. *J Anim Sci.* 90 3220–4676.

Weschenfelder A, Torrey S, Devillers N, Crowe T, Bassols A, Saco Y, (2013) Effects of trailer design on animal welfare parameters and carcass and meat quality of three Pietrain crosses being transported over a short distance. *Livest Sci.* 157 234–44.

White, H.M., Richert, B.T., Schinckel, A.P., Burgess, J.R., Donkin, S.S. and Latour, M.A. (2008). Effects of temperature stress on growth performance and bacon quality in grow-finish pigs housed at two densities. *J. Anim. Sci.* 86: 1789-1798.

Wiggins, S. (2009). Can the smallholder model deliver poverty reduction and food security for a rapidly growing population in Africa? Background paper for the Expert Meeting on How to feed the World in 2050, Food and Agriculture Organization of the United Nations. See http://www.fao.org/docrep/012/ak542e/ak542e00.htm.

Williams, T.O., Spycher, B. and Okike, I. (2006). Improving livestock marketing and intraregional trade in West Africa: Determining appropriate economic incentives and policy framework. ILRI (International Live stock Research Institute), Nairobi Kenya. 122.

Woolhouse M. (2006). Mathematical modelling of future infectious diseases risks: an overview. Foresight, infectious diseases: preparing for the future, office of science and innovation. http://www.foresight.gov.uk/Infectious%20Diseases/t8_1.pdf

Whittemore, C. T. 1998. The science and practice of pig production. 2nd ed. Blackwell Science, Oxford;Malden, M.A.

Wolter, B. F., M. Ellis, B. P. Corrigan, J. M. DeDecker, S. E. Curtis, E. N. Parr, and Webel, D.M. (2003). Effect of restricted postweaning growth resulting from reduced floor and feeder-through space on pig growth to slaughter weight in a wean-to-finish production system. *Journal of Animal Science* 81: 836-842.

World Bank. (2009). Minding the stock: bringing public policy to bear on livestock sector development. Washington, DC: 2009. Report no. 44010-GLB.

Zhang, W, Yu, E.A., Rozelle, S., Yang, J., Msang, S. (2013). The impact of biofuel growth on agriculture: Why is the range of estimates so wide? Food Policy 38, 227–239.

APPENDIX 1

Central University of Technology, Free State

DEVELOPING A MARKETING MODEL TO ASSIST FREE STATE SWINE PRODUCERS TO MAXIMIZE PROFIT

LOCATION: _____

Dear Sir/Madam,

As part of the requirement for the award of D. Tech. studies at the marketing Department of the Faculty of Management Sciences of the Central University of Technology (CUT), Free State, I am undertaking a research on Developing a Marketing Model to Assist Free State Swine Producers to Maximize Profits. The research is set to find out why the Free State Swine producers cannot maximize profit and to propound a model or strategies that will assist them to maximize profits. Your farm has been carefully chosen to participate in this study. The questions will take about 40mins.of your time.

Be assured that the information you gave will in no way reveal your identity. Your cooperation and viewpoints are very important to the success of this study and will be kept strictly confidential.

Kind regards,

Gideon C. Uboegbulam
Department of Business Administration
Faculty of Management Sciences
Central University of Technology (CUT)
Free State.

SECTION A. DEMOGRAPHY

Q1. What is your gender?

Male ☐

Female ☐

Q2. How old are you?

(a) 25 – 35yrs ☐

(b) 36 – 45yrs ☐

(c) 46 – 55yrs ☐

(d) 56 – 65yrs ☐

(e) 66yrs and above ☐

Q3. How long have you been in swine farming enterprise?

(a) 1 – 4yrs. ☐

(b) 5 -10yrs. ☐

(c) 11 – 15yrs. ☐

(d) 16yrs. and above ☐

Q4. What is your marital status?

(a) Single ☐

(b) Married ☐

(c) Divorced ☐

(d) Widowed ☐

Q5. How many are members of your household?

(a) None ☐ (e) 5 ☐

(b) 2 ☐ (f) 6 ☐

(c) 3 ☐ (g) 7 and above ☐

(d) 4 ☐

Q6. What are the age(s) of your children?

(a) 1 – 5yrs ☐ (d) 16 – 20yrs ☐

(b) 6 – 10yrs ☐ (f) 21 and above ☐

(c) 11 – 15yrs ☐

Q7. To which race group do you belong?

(a) Black ☐ (b) White ☐

(c) Colored ☐ (d) Oriental ☐

(e) Other please specify ☐

Q8. What is your current educational qualification?

(a) Grade 6 ☐ (b) Matric ☐

(c) OND ☐ (d) Nat. certificate ☐

(e) HND ☐ (f) Bsc. ☐

(g) B. Tech ☐ (h) Msc. ☐

(i) Ph. D ☐ (j) Others please specify. ----------

Q9. What is your gross income per annum? ----------

SECTION B

This section deals with the best marketing strategies that maximize profit for the swine producers. It looks at the channels that will meet up with the strategies.

Q10. Do you send your swine to the abattoir?

(a) Yes ☐ (b) No ☐

Q11. Which of the following marketing channels do you use in marketing your swine?

(a) Wholesalers ☐ (b) Butcheries ☐

(c) Retailers ☐ (d) Neighbours/friends ☐

(e) Farmers market ☐ (f) Cooperatives ☐

(g) Specialist food stores ☐ (h) Processors ☐

(i) Consumers ☐

Q12. Do you belong to any swine organization?

(a) Yes ☐ (b) No ☐

Q13. If yes, what is the name of the swine organization? ----------

Q14. Would you to belong to a swine producer's cooperatives/body?

(a) Yes ☐ (b) No ☐

Q15. If yes, what is the name of the swine organization? ----------

SECTION C

The effects of stocking rate on swine growth: This section considers the impact of spacing to the growth of swine and production processes.

Q16. What is the size of your pen?

(a) 10.5m2 ☐ (b) 11.00m2 ☐ (c) 11.5m2 ☐

(d) Others please specify. ----------

Q17. What is the size of your furrowing unit? ----------

Q18. How many swine do you own?

(a) Piglets. ---------- (b) Weaners.---------- (c) Growers. ---------

(d) Gilts. ---------- (e) Young Boars.------- (f) Breeding Boars. -----

(g) Breeding Sows. ----------

Q19. Do you hire Boar for mating?

(a) Yes ☐ (b) No ☐

Q20. What are the average piglets produced by one swine?

(a) 5 ☐ (b) 10 ☐ (c) 15 ☐ (d) 16 and above ☐

Q21. How many piglets survive at weaning?

(a) None ☐ (b) 1 – 5 ☐ (c) 6 – 10 ☐ (d) 11 -15 ☐

(e) 16 and above ☐

Q22. Do you have farm attendants/workers?

(a) Yes ☐ (b) No ☐

Q23. If yes, how many are they? ----------

Q24. Where are your swine housed?

(a) Open space ☐ (b) Shaded/Covered ☐ (c) Others specify ☐

Q25. Do you consider overcrowding as one of the causes of piglets mortality?

(a) Yes ☐ (b) No ☐

Q26. If yes, how many piglets do you raise in one pen? ----------

Q27. Do you consider overcrowding as one of the causes of abortion/ premature fallowing in pregnant sows?

(a) Yes ☐ (b) No ☐

Q28. If yes, how many pregnant gilts/sows do you allocate per pen?

Q29. Can overcrowding retard the growth rate of swine?

(a) Yes ☐ (b) No ☐

Q30. At what age do you market your swine? ----------

Q31. Select the body weight at which you market your swine?

(a) 1 – 10kg ☐ (b) 11 – 20kg ☐ (c) 21 – 30kg ☐

(d) 31 – 40kg ☐ (e) 41 – 50kg ☐ (f) 51 – 60kg ☐

(g) 61 – 70kg ☐ (h) 71 – 80kg ☐ (i) 81 – 90kg ☐

(j) 91 – 100kg ☐ (k) Above 100kg ☐

Q32. How much does it cost to raise one swine to 100kg body weight? ----------

Q33. How much does it cost to raise one swine to a body weight of:

Body Weight (kg)	Cost (R)
10	
20	
30	
40	
50	
60	
70	
80	
90	
100	
Above 100	

Q34. Do these costs include feeds, labor, and medicine?

(a) Yes ☐ (b) No ☐

Q35. If no, what is the cost of the following?

(a) Feeds R------- (b) Medicine R------- (c) Labor R-------

SECTION D

The effect of stocking rate on swine marketing: This section considers the transportation cost, transportation space of swine in the lorry/van, distance to the market/abattoir, and transportation timeframes.

Q36. How much does it cost to transport one swine to the market or abattoir? ------

Q37. What is the distance from your farm to the abattoir or market? ----------

Q38. How long does it take to get to the abattoir or market? ----------

Q39. What methods are used in the loading of your swine in to the lorry/van?

Q40. Are the swine loaded according to the following?

(a) Age Yes ☐ No ☐ (b) Sex Yes ☐ No ☐

(c) Bodyweight Yes ☐ No ☐

Q41. Does the lorry/van have apartment to take care of different weights of the swine?

(a) Yes ☐ (b) No ☐

SECTION F

Impact of policies on operational and marketing of swine: This section considers the effect of government policies and trade unions on the marketing of swine.

Q42. Which government policies are applicable to swine production? ----------

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Q43. Which government policies affect the marketing of your swine? ----------

---

Q44. To what extent does government policies the marketing of your swine?

(a) To an effect ☐ (b) To a high effect ☐ (c) To a very high effect ☐

(d) No effect ☐ (e) Low effect ☐ (f) Very low effect ☐

Q45. Which trade union registration do you have? ----------

Q46. Does the trade union registration have effect on the marketing of your swine?

(a) Yes ☐ (b) No ☐

Q47. If yes, what are the effects?

(a) ---------- (b) ---------- (c) ----------

Q48. Do you have access to government agricultural subsidies?

(a) Yes ☐ (b) No ☐

Q49. If yes, what is the nature of the subsidies? ----------

Q50. Do you have access to bank loans?

(a) Yes ☐ (b) No ☐

Q51. If yes, how much have received since the last 5 years? R ----------

Q52. What problems do you encounter in your swine production enterprise?

(a) Lack of fund ☐ (b) Transportation c☐ (c) Govt. policie☐

(d) Cost of feed/medicine ☐ (f) Storage facilities ☐

(g) Price information ☐ (h) Others please specify ☐

Q53. In your opinion what do you think could reduce the cost of swine production? ---

---

Q54. Please, feel free to provide other comments that you consider necessary in the following categories:

(a) Problems experienced in swine production. ---

(b) Benefits from the swine production enterprise. ---

(c) Recommendations to swine producers. ---

(d) Recommendations to trade unions. ---

(e) Recommendations to government. ---

(f) Recommendations to banks/financial agencies. ---

Thank you very much and remain blessed.

APPENDIX 2

TEST RE-TEST SCORES FOR RELIABILITY ANALYSIS

S/NO	X	X^2	Y	Y^2	XY
1	3.40	3.40	11.56	11.56	11.56
2	3.00	3.10	9.00	9.61	9.30
3	4.00	4.10	16.00	16.81	16.40
4	3.60	3.60	12.96	12.96	12.96
5	3.00	4.00	9.00	16.00	12.00
6	2.00	3.00	4.00	9.00	6.00
7	3.60	3.70	12.96	13.69	13.32
8	3.80	3.80	14.44	14.44	14.44
9	3.60	3.60	12.96	12.96	12.96
10	4.00	4.10	16.00	16.81	16.40
11	3.60	3.60	12.96	12.96	12.96
12	4.00	4.10	16.00	16.81	16.40
13	3.80	3.80	14.44	14.44	14.44
14	3.80	3.80	14.44	14.44	14.44
15	3.60	3.70	12.96	13.69	13.32
16	3.80	3.80	14.44	14.44	14.44
17	3.20	3.30	10.24	10.89	10.56
18	3.80	3.80	14.44	14.44	14.44
19	3.40	3.50	11.56	12.25	11.90
20	3.40	4.00	11.56	16.00	13.60
21	3.00	3.10	9.00	9.61	9.30
22	2.60	2.70	6.76	7.29	7.02
23	3.00	3.00	9.00	9.00	9.00
24	3.60	3.00	12.96	9.00	10.80
25	3.00	3.00	9.00	9.00	9.00
26	3.00	3.10	9.00	9.61	9.30
27	3.60	3.60	12.96	12.96	12.96
28	3.80	3.00	14.44	9.00	11.40
29	3.60	3.70	12.96	13.69	13.32

30	3.90	4.00	15.21	16.00	15.60
	$\sum X=103.50$	**$\sum Y=106.00$**	**$\sum X^2=363.21$**	**$\sum Y^2=379.36$**	**$\sum XY=369.54$**

N = 30

$$r = \frac{N\sum xy-\left(\sum x\right)\left(\sum Y\right)}{\sqrt{N\left[\sum x^2-\left(\sum x\right)^2\right]\left[N\sum Y^2-\left(\sum Y\right)^2\right]}}$$

$$r = \frac{30x369.54-(103.5)(106)}{\sqrt{\left[30x363.21-(1035)^2\right]\left\{30x379.36-(106)^2\right\}}}$$

$$r = \frac{11086-10971}{\sqrt{(10896-10712)(11381-11236)}}$$

$$r = \frac{115.2}{\sqrt{(184.05)(144.8)}}$$

$$r = \frac{115.2}{\sqrt{26650.44}}$$

$$r = \frac{115.2}{163.25}$$

r = 0.71

APPENDIX 3

Regression Analysis showing the Effects of membership of Swine Organisation, Government Agricultural Subsidy, Bank Loan, Cost of production, Cost of transportation to Market or Abattoir and Overcrowdding on Gross income of the respondents

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Membership of swine organisation, Access to bank loan, Production Cost, Access to government agricultural subsidies?[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Gross income of swine producers in Free State

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.925[a]	.855	.848	.758

a. Predictors: (Constant), Membership of swine organisation, Access to bank loan, Production Cost, Access to government agricultural subsidies?

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	254.876	4	63.719	110.946	.000[a]
	Residual	43.074	75	.574		
	Total	297.950	79			

a. Predictors: (Constant), Membership of swine organisation, Access to bank loan, Production Cost, Access to government agricultural subsidies?

b. Dependent Variable: Gross income of swine producers in Free State

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.220	.784		.280	.780
	Production Cost	-1.686	.090	-.963	-18.720	.000
	Access to government agricultural subsidies?	.688	.519	.078	1.325	.189
	Access to bank loan	.046	.272	.008	.169	.866
	Membership of swine organisation	.160	.330	.029	.485	.629

a. Dependent Variable: Gross income of swine producers in Free State

APPENDIX 4

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
stocking rate adopted by swine producers in Free State	80	2.1875	1.00749	.11264

One-Sample Test

	Test Value = 2.5					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
stocking rate adopted by swine producers in Free State	-2.774	79	.007	-.31250	-.5367	-.0883

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Marketing channels adopted	80	3.01	1.119	.125

One-Sample Test

	Test Value = 3.0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Marketing channels adopted	.100	79	.921	.013	-.24	.26

APPENDIX 5

Table 6.1: Demographic/Profile Analysis.

Demographic variables	**Frequencies**	**%**
1. Sex;		
Male	47	26.5
Female	33	41.3
Total	**80**	**100**
2. **Age;**		
25 - 35 Years	4	5.0
36 - 45 Years	13	16.3
46 – 55 Years	28	35.0
56 – 65 Years	30	37.5
66 Years and above	5	6.3
Total	**80**	**100**
3. **How long the Respondents have been in Swine Enterprise;**		
1 - 4 Years	36	45.0
5 - 10 Years	24	30.0
11 – 15 Years	7	8.8
16 Years and above	13	16.3
Total	**80**	**100**
4. Marital Status;		
Single	5	6.3
Married	56	70.0
Divorce	2	2.5
Widowed	17	21.3
Total	**80**	**100**
5. Household Size of the Respondents		
None	34	42.5
1-3	23	28.75
4-6	16	20.0
>6	7	8.75
Total	80	100
6. **Race of the Respondents**		
Black	78	97.5
White	2	2.5
Total	80	100
7. Respondents who send their Swine to the Abattoir		
Yes	23	28.8
No	57	71.2
Total	80	100
8. Respondents who belong to Swine Organisations		
Yes	11	28.8
No	69	71.2
Total	80	100
9. Age of the Respondents' Children		
1-5 Years	1	1.3
6-10 Years	4	5.0

11-15 Years	7	8.8
16- 20Years	18	22.5
> 20 Years	26	32.5
Not applicable	24	30.0
Total	80	100
10. Educational Qualification of the Respondents		
Grade 6	22	27.5
Matric	33	41.3
National certificate	5	6.3
BSc	6	7.5
B.Tech	3	3.8
MSc	1	1.3
No Formal Education	10	12.5
Total	80	100
11. Gross Income of the Respondents;		
< R 1000	13	16.3
R 1,000 – R 10,000	35	43.8
R 11,000 – R 20,000	11	13.8
R 21,000 – R 30,000	2	2.5
R 31,000 – R 40,000	5	6.3
R 41,000 – R 50,000	5	6.3
>R 50,000	9	11.3
Total	80	100
12. Marketing Channels used by the Respondents		
Whole sales	6	7.5
Butchery	19	23.8
Retails	35	43.8
Neighbours/Friends	8	10.0
Farm Market	12	15.0
Total	**80**	**100**

Source: SPSS 20.0 Output (based on 2015 field survey data) Detail in Appendix 2 -14

APPENDIX 6

Number of agricultural households owning Pigs by local municipality (Department of Agriculture Free State Province)

Local municipality	1-10	11-100	+100	Total
Dihlabeng	184	46	8	239
Kopanong	160	44	5	208
Letsemeng	102	26	1	129
Mafube	86	41	10	137
Maluti a Phofung	1,028	94	7	1,128
Mangaung	529	187	16	732
Mantsopa	113	15	6	134
Masilonyana	95	25	1	121
Matjhabeng	330	102	10	442
Metsimaholo	68	17	3	88
Mohokare	77	19	1	97
Moqhaka	410	71	10	492
Nala	183	38	6	226
Naledi-FS	51	14	.	65
Ngwathe	270	59	11	340
Nketoana	148	28	8	184
Phumelela	131	27	1	159
Setsoto	289	73	6	368
Tokologo	137	21	.	158
Tswelopele	262	30	4	296
Province	**4,651**	**979**	**115**	**5,744**