Economic feasibility study of the establishment of smallholder pig farmers for the commercial market: Empolweni case study

by
Johannes Jacobus Roelofse

Thesis presented in partial fulfilment of the requirements for the degree Master of Science in Engineering (Engineering management) at the University of Stellenbosch

Supervisors:
Mr. Nico Treurnicht
Department of Industrial Engineering
Faculty of Engineering

Mrs. Lindie Liebenberg
Department of Animal Sciences
Faculty of Agri-Sciences

December 2013

Declaration

By submitting this thesis, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Signed:	Hanno Roelofse
Date:	2013-08-31

Abstract

Food security is a national priority, according to Section 27 of the South African Constitution. It states: "Every citizen has the right to have access to sufficient food and water, and that the state must by legislation and other measures, within its available resources, avail to progressive realisation of the right to sufficient food." Nevertheless, while food security is clearly a government priority and regardless of the country being considered as self-sufficient in respect of food production, food insecurity remains a dire South African challenge.

This study presents the improvement of smallholder pig farmers to a commercial standard with funding from the government as a potential means to address poverty and food insecurity in South Africa. Commercial standard pig farms as opposed to smallholder pig farms provide increased employment, food production, biosecurity and food safety. This investigative study evaluates the economic feasibility of a smallholder commercial pig farm in the Mamre area. The Empolweni community's pig farmers serve as the case study and as an example of a typical smallholder pig farming community. Their current operations are studied, the requirements for a conversion to a commercial standard are assessed and the profitability and sustainability of the proposed commercial model is judged.

The study's findings indicate that specific scenarios (high production performance, large pig farm unit sizes, pork price increases or feed costs reductions) a commercial smallholder pig farm can achieve economic feasibility. However, trends indicate that there is low likelihood of the required conditions to achieve economic feasibility will be able to occur. The thesis judges only the potential economic feasibility of the case study, as opposed to the economic feasibility of commercial smallholder pig farmers on a national or regional level.

Opsomming

Voedsel sekuriteit is ‘n nasionale prioriteit en vorm deel van die Artikel 27 Grondwetlike regte in Suid-Afrika. Die Grondwet stel dat elke landsburger die reg op toegang tot voldoende voedsel en water het en dat die staat deur middel van wetgewing en ander maatreëls, binne sy beskikbare middele, progressiewe verwesenliking van die reg op voldoende voedsel moet laat geskied. Nietemin, alhoewel voedsel sekuriteit ongetwyfeld ‘n prioriteit van die regering is en ten spyte daarvan dat Suid-Afrika as selfonderhoudend ten opsigte van voedselproduksie gesien word, heers onvoldoende voedsel sekuriteit steeds.

Hierdie studie stel die volgende moontlike oplossing voor: Suid-Afrikaanse kleinskaalse varkboere moet hul bedrywighede opgradeer na 'n kommersiële standaard. Verskeie redes kan gegee word waarom hierdie oplossing 'n gangbare opsie bied om armoede en voedselsekuriteit in Suid-Afrika teë te werk. Kommersiële varkboere, in teenstelling met kleinskaalse varkboere, bied verhoogde vlakke van voedselproduksie, werkskepping, biosekuriteit en veiliger voedingsbronne. Hierdie studie poog om die ekonomiese gangbaarheid van ‘n kleinskaalse kommersiële varkplaas in die Mamre omgewing te bepaal. Die Empolweni gemeenskap se varkboere dien as 'n gevallestudie van ‘n tipiese kleinskaalse varkboerdery gemeenskap. Hul huidige bedrywighede is ondersoek, die benodighede vir ‘n opgradering is bepaal en die winsgewendheid en volhoubaarheid van die kommersiële model is beoordeel.

Bevindings toon dat vir spesifieke gevalle (hoë produksievlakke, groot varkplaaseenhede, varkprys verhogings en voerkoste verlagings) ‘n kommersiële kleinskaalse varkplaas ekonomiese gangbaarheid kan behaal. Alhoewel, tendense toon dat daar ‘n lae waarskynlikheid is dat die nodige kondisie om ekonomiese gangbaarheid te behaal sal kan plaasvind. Die tesis oorweeg slegs die ekonomiese gangbaarheid van die gevallestudie. Die ekonomiese gangbaarheid van kleinskaalse varkboere op ‘n nasionale of streeksvlak word dus nie ingesluit nie.

Acknowledgements

I would like to express my sincere gratitude and appreciation to:

- My supervisors: Mr N. Treurnicht and Mrs L. Liebenberg for their guidance and support during my research.
- Mr C. Venter for always being available and for providing thesis progression advice.
- The Empolweni community (especially Mr D. Steyl and Mrs Bennet) for distributing and answering my case study questionnaires.
- The various pig production experts that I consulted to gain detailed information about the pork industry.
- I would also like to acknowledge the financial support that I received from the Stellenbosch OSP fund.
- Lastly, I take this opportunity to thank my family and friends for supporting me during my studies.

Table of contents

Declaration i
Abstract ii
Opsomming iii
Acknowledgements iv
Table of contents v
List of Figures ix
List of Tables x
Glossary xi

1. Introduction 1
- 1.1. South African food security 1
- 1.2. The role of agriculture 2
- 1.3. Pig farming potential 3
  - 1.3.1. Food production 3
  - 1.3.2. Employment opportunities 3
  - 1.3.3. Land requirements 4
  - 1.3.4. Food safety 4
- 1.4. Objective of the study 4

2. Literature study 5
- 2.1. Research methodology 5
- 2.2. Pig production modelling 6
  - 2.2.1. Pig production cycle 6
  - 2.2.2. Production performance 8
- 2.3. Smallholder pig farming budgeting 12
  - 2.3.1. Start-up costs 12
  - 2.3.2. Income 14
  - 2.3.3. Production costs 17
  - 2.3.4. Profit / Loss 27
- 2.4. Smallholder pig farming challenges 28
  - 2.4.1. Feed 28
  - 2.4.2. Water 29
  - 2.4.3. Funding 29
  - 2.4.4. Housing 29
  - 2.4.5. Heating 30
  - 2.4.6. Pig production expertise 32
  - 2.4.7. Biosecurity 32
  - 2.4.8. Marketing 34
  - 2.4.9. Security of tenure 35

2.5. Literature study overview 35

3. Methodology 36
3.1. Problem statement 36
3.2. Data gathering 36
3.3. Analysis 37
3.4. Evaluation 37
3.5. Findings 37

4. Analysis 38
4.1. Case study community overview 38
4.1.1. Housing, infrastructure and equipment 38
4.1.2. Feed 39
4.1.3. Water 39
4.1.4. Biosecurity and health management 40
4.1.5. Labour 40
4.1.6. Pig farming experience 40
4.2. Production performance gap analysis 41
4.2.1. Current case study community production performance 41
4.2.2. Pig production performance gaps 42
4.2.3. Gap analysis findings 42
4.3. Design considerations 43
4.3.1. Housing, infrastructure and equipment 43
4.3.2. Heating 44
4.3.3. Pig production training 44
4.3.4. Feed 44
4.3.5. Water 45
4.3.6. Biosecurity 45
4.3.7. Genetics 45
4.4. Base commercial smallholder pig farm model 45
4.4.1. Production plan 46
4.4.2. Start-up costs 47
4.4.3. Estimated annual income 48
4.4.4. Estimated annual production costs 49
4.4.5. Base model overview 57

5. Evaluation ... 58
5.1. Production performance scenarios ... 58
5.2. Sensitivity analysis ... 59
5.2.1. Pork prices ... 60
5.2.2. Feed costs ... 63
5.2.3. Living costs ... 65
5.2.4. Interest on loans ... 67
5.2.5. Unit size ... 70
5.2.6. Growth rate ... 72
5.2.7. Live weight at slaughter ... 72
5.3. Evaluation overview ... 73
5.3.1. Scenario 1 ... 73
5.3.2. Scenario 2 ... 74
5.3.3. Scenario 3 ... 74
5.3.4. Scenario 4 ... 75

6. Findings ... 76
6.1. Positive findings ... 76
6.1.1. Household income ... 76
6.1.2. Food production ... 76
6.1.3. Supporting local business ... 76
6.1.4. Animal welfare ... 76
6.1.5. Pork industry biosecurity ... 77
6.2. Negative findings ... 77
6.2.1. Sustainability ... 77
6.2.2. High start-up costs ... 77
6.2.3. Learning curve ... 77
6.2.4. Disease outbreaks ... 77
6.2.5. Pig production unit size ... 78

7. Conclusion ... 79
7.1. Summary of contributions ... 79
7.2. Future research ... 80

8. References ... 81

9. Addendum 89
9.1. Solar power quotations 89
9.1.1. Sunflare 90
9.1.2. Sustainable.co.za 91
9.1.3. Sinetech 92
9.2. Empolweni community questionnaire 93
9.3. Casidra pig housing cost estimate 106
9.4. Batch farrowing system 107
9.5. Evaluation equations overview 108
9.5.1. Start-up costs 108
9.5.2. Income 108
9.5.3. Production costs 109
9.5.4. Results 112

List of Figures

Figure 2.1 Graphical representation of the example pig production cycle's timeline 8
Figure 2.2 South African historic average monthly porker and baconer prices 16
Figure 2.3 South African historic average monthly yellow maize prices 20
Figure 5.1 The effect of pork price adjustments on the scenarios' profit / loss 61
Figure 5.2 The effect of pork price adjustments on the scenarios' ROI 61
Figure 5.3 South African historic average annual pork prices 62
Figure 5.4 South African historic average yellow maize gross producer prices 63
Figure 5.5 The effect of feed cost adjustments on the scenarios' profit / loss 64
Figure 5.6 The effect of feeds cost adjustments on the scenarios' ROI 64
Figure 5.7 The effect of monthly living costs adjustments on the scenarios' profit / loss 66
Figure 5.8 The effect of monthly living costs adjustments on the scenarios' ROI 66
Figure 5.9 The effect of interest on loans for start-up costs on the scenarios' ROI 67
Figure 5.10 The effect of interest on loans for non-production start-up costs and half a year's production costs on the scenarios' ROI 68
Figure 5.11 The effect of interest on loans for one year's production costs on the scenarios' ROI. 68
Figure 5.12 The effect of interest on loans for half a year's production costs on the scenarios' ROI 69
Figure 5.13 The effect of increased unit sizes on the scenarios' ROI 70
Figure 5.14 The effect of increased unit sizes (with feed discounts) on the scenarios' ROI 71
Figure 5.15 The effect of reduced growth time on the scenarios' ROI 72
Figure 9.1 Smallholder commercial pig farm three week batch farrowing system 107

List of Tables

Table 2.1 Average daily live weight gain per production stage 10
Table 2.2 The dressing percentage of eight different live slaughter weights 14
Table 2.3 Meadow Feeds' pricelist 17
Table 2.4 Meadow Feeds' feed costs to produce a 100 kg live weight pig 18
Table 2.5 Nova Feeds' pricelist 18
Table 2.6 Nova Feeds' feed costs to produce a 100 kg live weight pig 19
Table 2.7 Monthly fresh water cost structure 23
Table 2.8 Monthly sanitation cost structure 24
Table 4.1 Feed supply details per production stage 39
Table 4.2 The Empolweni community's estimated average pig production performance 41
Table 4.3 Case study community pig production performance gaps 42
Table 4.4 Base model and maximum potential production performance 46
Table 4.5 Base model's financial information 57
Table 5.1 Production performance scenarios' parameters 58
Table 5.2 Production performance scenarios' financial information 59
Table 9.1 Comparison of 175 Watt single heating lamp solar power costs (for 24 and 12 hours per day) between three companies 89
Table 9.2 Estimated cost for Casidra pig housing, infrastructure and equipment 106
Table 9.3 Base model feed costs calculation 109

Glossary

Concept	Description
Baconer	Slaughter pigs with a carcass weight of between 56 and 90 kg.
Biosecurity	Biosecurity refers to the precautions taken to minimise the risk of introducing an infectious disease into an animal population.
Carcass weight	The weight of a slaughtered pig's cold carcass, either whole or divided in half along the mid-line, after exsanguination and evisceration and after removal of the tongue, bristles, hooves, genitalia, flare fat, kidneys and diaphragm.
Commercial pig production	Commercial pig production refers to pig farms that sell their pigs to registered abattoirs as opposed to most smallholder pig farmers slaughtering their own pigs or selling live pigs to the informal market.
Creep feed	Feed that are provided to nursing piglets.
Dressing / killing-out percentage	The carcass weight as a percentage of a pig's live weight at slaughter.
Economic feasibility study	A study to determine if a venture is potentially sustainably profitable.
First filial (F1) cross	The F1 generation pig offspring from a cross mating of different parental types/breeds. The offspring produces a new, uniform variety with specific characteristics from either or both parents.
Farrowing	Delivery of one or more alive or dead pigs, on or after the 110th day of pregnancy. Abortions are excluded from the farrowing tallies.
Farrowing interval	The number of days between a sow's two consecutive farrowings.
Farrow-to-finish	A pig raising system in which piglets are born, reared, weaned, grown and fattened at the same facility, as opposed to systems where the pigs are moved to other facilities / pig production units at each major stage of their development.
Finisher	Grower pigs that weigh more than 70 kg (live weight).
Food security	Food security refers to an individual's ability of having daily access to sufficient food of adequate nutritional value. Consequently, a food secure nation will have low incidences of hunger or malnutrition.
Grower	A weaned pig older than eight weeks or weighing more than 20 kg (live weight).
Live weight	The gross weight of a living pig.
Oestrus	The period of sexual excitement (heat) and a certain hormonal profile, at which time the sow will accept coitus (standing heat).
Piglet	A newly born or suckling pig.
Porker	Slaughter pigs with a carcass weight of between 21 and 55 kg.
SAPPO	South African Pork Producers' Organisation.
Service	The mating or artificial insemination of a sow.
Slaughter weight	The live weight of the pig at slaughter.
Smallholder pig farmer	Pig farmers who slaughter own livestock for informal sale or their own consumption. Also referred to as small scale, subsistence or communal pig farms.
Swill feed	Swill feed refers to any animal or bird matter (meat, feathers, and faeces), as well as fruit and vegetable scraps used as pig feed. It is generally obtained from kitchen waste (restaurants, prisons and homes).
Terminal cross	The offspring resulting from a terminal cross sow or boar are not used for breeding programs or genetic improvement. Generally, the offspring are market pigs.
Weaner	A pig between weaning and either eight weeks of age or 20 kg live weight.

1. Introduction

The South African Constitution (Constitutional Court, 1996, Chapter 2, Section 27.1b) states that every citizen has the right to sufficient food and water and that the state will take reasonable legislative and other measures, within its means, to achieve this goal. The National Department of Agriculture initiated the Integrated Food Security Strategy (IFSS) (Department of Agriculture, 2002), in conjunction with the Millennium Development Goals (Statistics South Africa & United Nations Development Programme, 2010), to achieve the national realisation of physical, social and economic access to adequate, safe and nutritious food to meet the dietary requirements of the nation.

However, food insecurity is rife in South Africa.

1.1. South African food security

South Africa is able to produce or import sufficient staple foods to meet the basic nutritional needs of its citizens (Food and Agriculture Organization of the United Nations, 2008; Altman, et al., 2009). Therefore, the nation is considered as food secure. However, food security has been achieved only on a national level and there is clear evidence that food security has not been achieved at a rural level (Altman, et al., 2009).

The General Household survey found that the incidence of inadequate or severely inadequate access to food had increased from 20% in 2009 to 21.9% in 2010. In 2010, the most severe levels of food insecurity were concentrated in the North West province. An estimated 33.3% of the households in this province had inadequate or severely inadequate access to food. North West's food insecurity level was followed by those of Kwazulu-Natal (26.9%), the Northern Cape (26%) and the Free State (23.6%) (Statistics South Africa, 2010; Statistics South Africa, 2011).

South Africa's high unemployment rate is one of the primary contributors to the country's food insecurity levels (United Nations Development Programme, 2006). Statistics South Africa's Quarterly Labour Force Survey (Statistics South Africa, 2011), July to September 2011, found that the national unemployment rate was 25% (narrow definition of unemployment). The narrow definition of unemployment considers only all unemployed citizens that have searched for work within the four weeks prior to responding to the survey.

The dismal state of South African food security requires decisive action because the long-term effects of such high rates of hunger on the developmental quality and potential of the workforce is extraordinarily detrimental to the growth and sustainability of a nation (Altman, et al., 2009).

1.2. The role of agriculture

Agriculture plays an important role in the alleviation of global food insecurity and poverty by creating employment opportunities for rural communities and by reducing food prices through efficient production methods (Food and Agriculture Organization of the United Nations, 2004).

The World Development Report (World Bank, 2007) researched the influence of the agriculture industry on poverty alleviation in 42 developing countries from 1981 to 2003. Findings showed that every 1% increase in a country's GDP (attributed to the agriculture output), increased the spending power of the poorest citizens (the lowest 30%) at least 2.5 times more than it did that of the rest of the population. Another study (Bravo-Ortega & Lederman, 2005) found that an increase in GDP attributed to agriculture activities had an average effectiveness in increasing the income of the poorest 20% in emerging countries by 2.9 times more than that of comparable growth in the GDP attributed to non-agriculture sectors.

The benefits created by agriculture activities are not limited to large-scale farming operations, because smallholder farms contribute a significant portion of the benefits. Generally, smallholder farmers have the following characteristics (Ethical Trading Initiative, 2005; Cousins, 2010):

- Small production volumes on a small plot of land (compared to large-scale farming).
- Less access to resources than large-scale or commercial-scale farmers.
- Primarily contribute to the informal economy. Only a small percentage of smallholder farmers sell their produce to formal markets.
- Primarily operate the farm by means of family or community labour.

European countries, Indonesia, Japan and Brazil have increased their food output by implementing effective support programmes to decrease food insecurity and poverty (Altman, et al., 2009; Chmielewska & Souza, 2010). The Food and Agriculture report (Wiggins, 2009) states that comparable results are achievable in Africa, as proven by studies of smallholder farms in several African countries.

The Production Economics Unit of the Economic Services Directorate estimates that 4 million South Africans are primarily involved in subsistence smallholder farming (Du Toit, et al., 2011) and the Labour Force Survey (Statistics South Africa, 2008) indicates that agricultural activities contribute 15% (35% for the poorest quartile) of a black household's income. Aliber & Hart (2009) and Altman et al. (2009) state that South African agriculture support programmes benefit only a small number of households. Smallholder farmers are unlikely to improve their current food production levels if support structures are insufficient (Food and Agriculture Organization of the United Nations, 2004). Therefore, support (expert support allocation and funding) to smallholder farmers offers a potential solution for South Africa's food security challenges.

1.3. Pig farming potential

Numerous smallholder pig farming success stories are available from around the world, including Namibia (Petrus, et al., 2011), Vietnam (Lapar & Staal, 2010) and Lao People's Democratic Republic (Phengsavanh, et al., 2011). Success is defined as the realisation of profitable and self-sustaining smallholder pig farmers. The smallholder pig farmers were able to achieve success because of sufficient agriculture extension support, funding and/or the involvement of cooperative communities.

This section discusses the potential opportunities and benefits that South African smallholder pig farmers producing at a commercial standard can provide to the nation.

1.3.1. Food production

Pigs are genetically superior at converting feed to meat when compared to ruminant livestock. A pig's feed to meat conversion efficiency can be as high as twice the conversion efficiency of ruminant livestock (Mpofu & Makuza, 2003).

The United Kingdom's pig statistics show that an average of 21.2 pigs (90 kg live slaughter weight) was sold per sow per year (Kyriazakis & Whittemore, 2006). Therefore, a single sow produced an average live weight of 1 908 kg (21.2 x 90 kg). A total of 1 483.66 kg pork can be produced per year with a dressing percentage (the percentage of carcass weight to live weight) of 77.76% (Pieterse, 2006, p. 53). If the average pork consumption rate of 4.1 kg per person per year (South African pork consumption per capita for 2008) remains, a single sow can potentially provide the pork demand of more than 361 South Africans per year (Directorate of Agricultural Statistics, 2010).

Additionally, pork is considered as a nutritious food source and its lean meat is rivalled only by poultry (Kyriazakis & Whittemore, 2006).

1.3.2. Employment opportunities

There are an estimated 400 commercial pig farms and 4 000 smallholder pig farmers in South Africa. Combined, they have approximately 125 000 sows (100 000 on commercial farms and 25 000 on smallholder farms) and they employ over 10 000 workers (4 000 labourers and 6 000 processing and abattoir workers) (Directorate Marketing, 2010c).

A study of smallholder pig producers in Vietnam found that pig farming activities create jobs for otherwise unexploited household labour. Female household members constituted 54 to 71% of pig farm labour for Vietnamese smallholder pig farms (Lapar & Staal, 2010). Pig farming can therefore provide employment opportunities to household members that are unemployed because of mobility constraints as a result of household responsibilities and childcare (Lapar & Staal, 2010; Tisdell, 2010).

1.3.3. Land requirements

Smallholder livestock farmers rarely have access to the large tracts of pasture land that are required for beef (Humane Farm Animal Care, 2004) or mutton production (Humane Farm Animal Care, 2005). In contrast, pigs and poultry can be housed under enclosed, environmentally controlled, conditions on small plots of land (Mpofu & Makuza, 2003; Humane Farm Animal Care, 2008; Seavey & Porter, 2009).

1.3.4. Food safety

Smallholder pig farms' low biosecurity standards present a danger to South African commercial pig farmers and consumers (Randolph, 2002; Normile, 2005):

- Smallholder pig farms increase the potential of disease outbreaks.
- Pig disease outbreaks reduce demand for pork products because of the consumers' fears.
- Diseases decrease a pig farm's production performance.

However, the most dire consequence of low biosecurity standards is the spread of zoonotic diseases (animal diseases that can infect humans), such as *Salmonella* (European Food Safety Authority, 2009) and *Campylobacter* (Uaboi-Egbenni, et al., 2011). A study of three pig farms in the Venda region, Limpopo province, found that 30.2% of 450 (150 from each farm) pig faeces samples tested positive for *Campylobacter* (Uaboi-Egbenni, et al., 2011). The pig carcass is thoroughly examined before being processed at registered abattoirs. In contrast to registered abattoirs, no formal quality checks are performed for informal slaughter. Therefore, informal slaughter has a significantly higher potential (compared to registered abattoirs) of selling pork that is unfit for human consumption. Consequently, pork safety and quality could be significantly improved if more smallholder piggeries were improved to commercial standards.

1.4. Objective of the study

As discussed in the previous section, commercial smallholder pig farming can potentially facilitate the alleviation of South African food insecurity and poverty. This study considers the economic feasibility of improving a smallholder pig farm to a commercial standard. The research question is as follows:
"Is it economically feasible for a smallholder piggery to convert to a commercial standard?"

The study's findings are based on a case study - the Empolweni community (in close proximity to Mamre) and the economic feasibility of the case study commercial pig farm is determined by the potential of sustainable profits being generated. The case study's findings will allow the researcher to comment on the reasons why, or why not, the case study was able to achieve economic feasibility. However, this thesis judges the potential economic feasibility of the case study only, as opposed to the economic feasibility of commercial smallholder pig farmers on a national or regional level.

2. Literature study

2.1. Research methodology

The case study research method focuses on the dynamics within a single setting to potentially shed light on a larger range of cases. Subsequently, the research method can be used to refine a broad field of research into a more easily manageable research topic (Yin, 2002). Additionally, the case study research method provides a viable research approach when it is impractical to collect data from a large sample population (Zainal, 2007).

Yin (2002) discusses some of the criticism against case study research:

- Findings are generalised without sufficient evidence and assumed to be applicable to the larger population.
- The results from case study research are susceptible to researcher bias.
- Case study research is considered as useful only for exploratory research.

The case study method is judged as ideal for the proposed research. It allows the researcher to make a statement on whether or not it is economically feasible for smallholder pig farmers in a single setting (the case study), with specific assumptions, to improve their operations to a commercial standard. The findings from this single setting can act as a guide to judge the feasibility of the endeavour on a national or regional level by considering what factors contributed to the success or failure of the single setting. Therefore, the research is considered as exploratory research.

Soy (1997) and Yin (2002) recommend the following case study research approach:

1. Problem statement: The problem statement provides an unambiguous and brief description of the challenges that need to be addressed by the research. Additionally, the problem statement acts as a focus point for the research work and it allows the researcher to track the research and assess the outcome.
2. Data gathering: Collecting the sample data. Data gathering methods include surveys, interviews and physical measurements.
3. Analysis: Analysis involves dividing the data into manageable subjects, patterns, tendencies and associations. The summarised case study findings can then be used to construct a model for the evaluation.
4. Evaluation: An evaluation is performed by using the analysis’ findings, in conjunction with the guidance provided by the problem statement.
5. Findings: This step involves a discussion of the evaluation’s findings and provides an answer to the problem statement’s question.

2.2. Pig production modelling

Pig production modelling allows the researcher to gain an understanding of production potential and the impact that individual performance factors have on each other and the profitability of the pig farm (Gous, et al., 2006).

2.2.1. Pig production cycle

The pig production cycle refers to the various physiological stages in a pig's life. Kyriazakis & Whittemore (2006) provide an example of a typical commercial pig production cycle.

Breeding

Generally, servicing (mating or artificial insemination (AI)) is planned to occur a week after weaning, when the sow comes into oestrus (Pluske, et al., 2003; Kyriazakis & Whittemore, 2006). It is standard practice for pig farms that use only natural mating to have a boar to sow ratio of between 1:15 (Kyriazakis & Whittemore, 2006) and 1:20 (PIC, 2002). However, AI allows a producer to reduce the number of boars on the farm to a boar to sow ratio of 1:50 (South Africa) to 1:150 (USA), because the semen is obtained from off-site stud breeder farms. Additionally, AI provides the farmer with access to the best genetic lines in the world, and thus allows the achievement of optimal production performance (PIC, 2002). After weaning, the sow is placed in a pen adjacent to the boar's pen. The sight and scent of the boar in the adjoining pen encourages the sow to come into heat. This usually occurs 5 to 7 days after weaning. When the sow is in standing heat, she is either artificially inseminated or placed in the same pen as the boar for natural mating (Kyriazakis & Whittemore, 2006, p. 148). Boars are housed individually to prevent aggression toward each other (Kyriazakis & Whittemore, 2006).

Gestation

The average gestation (pregnancy) period lasts for an average of 115 days. The gestation duration is highly dependent on the season, the breed and the litter size (Kyriazakis & Whittemore, 2006, p. 126). Pregnant sows are housed individually or in groups (Kyriazakis & Whittemore, 2006).

Farrowing

The sow is transferred to a farrowing pen a week before farrowing to facilitate acclimatisation. Careful supervision is required for at least the first week after farrowing to ensure an optimal piglet survival rate. A farrowing crate helps to prevent piglet mortalities by sow crushing. The piglet is vaccinated and an iron injection is administered within the first week after birth (Wiseman, et al., 2003; Kyriazakis & Whittemore, 2006).

A creep area allows the piglets to congregate for warmth (body heat, bedding and heating). Heating lamps and/or floor heating are usually utilised to facilitate temperature control for the creep area and weaner pen (Wiseman, et al., 2003; Kyriazakis & Whittemore, 2006). This allows the piglets to use their energy to grow rather than using the energy to heat their bodies. It also prevent piglets from trying to gain heat by lying close to the sow and therefore be at risk of being accidentally crushed by the sow. Heating is required for the first 45 days after birth (depending on ambient temperatures) (Kyriazakis & Whittemore, 2006, p. 289). The creep area is inaccessible to the sow to prevent crushing of piglets and access to creep feed (Wiseman, et al., 2003; Kyriazakis & Whittemore, 2006).

The piglet is fed exclusively by the sow's milk for the first 14 days after farrowing. After 14 days, small amounts of creep feed are provided to the piglets along with suckling which allow the piglet to grow accustomed to dry feed before weaning (Kyriazakis & Whittemore, 2006, p. 503).

Weaning

Piglets are weaned (removed from the sow) at the age of 21 to 28 days at an average live weight of between 7.5 and 9 kg (Kyriazakis & Whittemore, 2006). However, it is possible to reduce the weaning age to a minimum of 19 days. A lower weaning age (weaning at an age of 21 days as opposed to 28 days) allows the sow to have more litters per year and it reduces the potential of disease transfer from the sow to the piglets. The lower weaning age requires high levels of nutrition, housing, supervision and expert knowledge (Pluske, et al., 2003, p. 17). A weaning age of less than 28 days is not recommended for non-intensive pig farms (primarily smallholder farmers) because of the increased management and housing requirements (Kyriazakis & Whittemore, 2006).

The sow is transferred to the breeding facilities and the weaned pigs are either housed in the nursery facilities or transferred to weaner housing. Heating is provided to the weaners (Kyriazakis & Whittemore, 2006).

Growing and finishing

The weaners are transferred to the grower housing at an age of between 58 days (live weight of approximately 20 kg) and 70 days (live weight of approximately 25 kg) as a result of increased needs in terms of feeding and space allowance and lower ambient temperature requirements. At the age of 118 days (live weight of 58 kg), the growers are transferred to the finisher housing (Kyriazakis & Whittemore, 2006, p. 598). For F1 cross or Purebred breeding systems, the best gilts and boars (those that show the characteristics of being healthy and potentially good breeders) are kept to replace the older or culled breeding stock (McGlone & Pond, 2003; Kyriazakis & Whittemore, 2006). For terminal cross breeding systems, breeding stock is replaced from outside the herd and all the offspring are destined for the market (McGlone & Pond, 2003; Kyriazakis & Whittemore, 2006).

Slaughter

The slaughter stage involves loading the pigs on the delivery truck and transporting them to the abattoir. The pigs are sold and slaughtered from the age of 118 days (58 kg live weight) to over 168 days (100 kg live weight). Culled breeding stock is sold as sausage pigs (Kyriazakis & Whittemore, 2006).

Pig production cycle overview

Refer to Figure 2.1 for a graphical representation of the example pig production cycle's timeline.

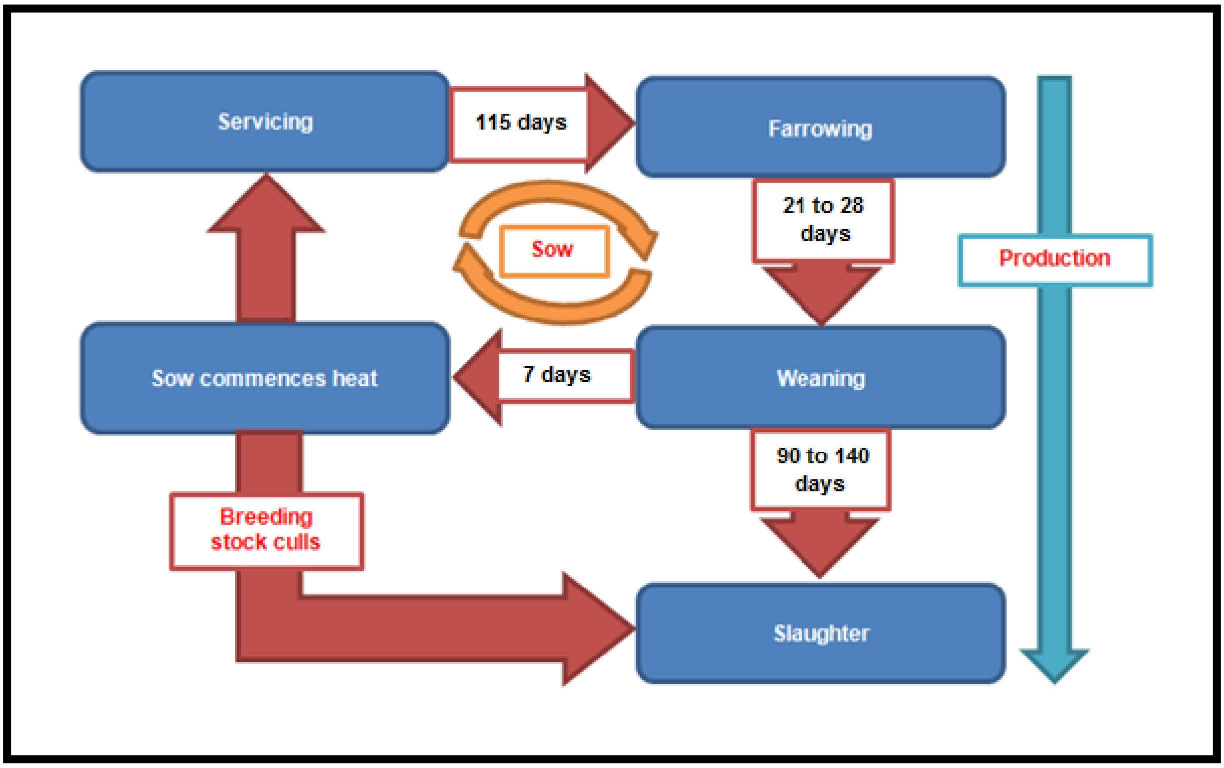


Figure 2.1 Graphical representation of the example pig production cycle's timeline

Source: Kyriazakis & Whittemore, 2006

The farrowing interval is 143 to 150 days and the farrow-to-slaughter time is 111 to 168 days for the pig production cycle discussed.

2.2.2. Production performance

The pig farmer needs to produce the correct quantity of the correct product (specific quality and pig type) at the lowest possible cost to succeed in pig farming (Key & McBride, 2007). McGlone & Pond (2003) uses the number of pigs produced per sow per year (PPSY) as the primary pig production performance measurement.

Simon Streicher, the CEO of the South African Pork Producers' Organisation (SAPPO), states that technological advances in veterinary health and manipulation have allowed the pig industry to increase the average PPSY from 20 to 26 (Louw, et al., 2011). Production performance parameters that affect the PPSY, as well as other vital performance parameters, are discussed in this section.

Number of litters per sow per year

The number of litters per sow per year is defined as the annual average number of litters that a sow produces. This production parameter can be improved by decreasing the weaning age, the non-productive days (days that a production sow is not pregnant or lactating), conception rate (percentage of first services that lead to conception) and sow mortalities (McGlone & Pond, 2003). The United Kingdom's average number of litters per sow per year is 2.34. According to an interview with Simon Streicher (discussed in Louw et al., 2011), the South African national average for intensive piggeries is 2.3 litters per sow per year.

Number of live born piglets per litter

The profitability of a pig production unit increases as the number of live born piglets per litter increases (Kyriazakis & Whittemore, 2006). This production performance parameter is primarily affected by the type of breed and the extent of heterotic effects (a phenomenon where the offspring display greater vigour than their parents because of hybridisation). Low prolificacy breeds produce an estimated eight live piglets per litter, while high prolificacy breeds can produce 13 piglets or more per litter (Kyriazakis & Whittemore, 2006). The United Kingdom's average number of live born piglets per litter is 10.9 (Kyriazakis & Whittemore, 2006) and the South African average is approximately 10.43 (interview with Simon Streicher as discussed in Louw et al., 2011).

Pre-weaning and post-weaning mortalities

The majority of mortalities occur within the first week after farrowing. The early mortalities are attributed to the inadequate mothering abilities of the sow, poor viability of piglets, exposure and anaemia (Oosterwijk, et al., 2003). Post-weaning deaths are attributed to environmental exposure, malnutrition and diseases (Kyriazakis & Whittemore, 2006). The United Kingdom's average pre-weaning mortalities percentage (expressed as a percentage of the number of live born piglets per litter) is 10.7% and the average post-weaning mortalities (expressed as a percentage of the number of weaned pigs per litter) percentage is 5.2% (Kyriazakis & Whittemore, 2006). Mortalities can be reduced by increasing supervision during farrowing, providing proper housing for each production stage, ensuring that the sow is lactating sufficiently and implementing effective biosecurity measures (McGlone & Pond, 2003; Kyriazakis & Whittemore, 2006).

Growth rate

The average daily live weight gain (ADG) is a measure of a pig's growth rate. Generally, it is measured in grams per day. Table 2.1 shows the ADG per production stage for the pig production cycle as discussed in Section 2.2.1.

Table 2.1 Average daily live weight gain per production stage

Production stage	Age at start (Days)	Age at end (Days)	Live weight at start (kg)	Live weight at end (kg)	Production stage duration (Days)	Production stage live weight gain (kg)	Growth rate per production stage (g/day)
Piglet	0	28	1.3	8.25	28	6.95	248
Weaner	28	70*	8.25	25	42	16.75	399
Grower	70*	118	25	58	48	33	688
Finisher	118	168	58	100	50	42	840

* Commercial piggeries move weaners to the grower houses at the age of 58 days (20 kg live weight). However, a more realistic weaner to grower housing age of 70 days is applicable to smallholder pig farmers to ease management and supervision requirements.

Source: Adapted from Kyriazakis & Whittemore, 2006

High ADG levels indicate that revenue can be generated at a faster rate because of short farrow-to-slaughter times and less housing space is required for high ADG levels, as opposed to low ADG levels (Kyriazakis & Whittemore, 2006).

Low ADG pig farms use a large percentage of their feed to maintain the slaughter pigs' live weight as opposed to utilising the feed to increase the herd's live weight (growth) (Kyriazakis & Whittemore, 2006). Therefore, at the same feed regime, a grower pig with a growth rate of 344 g/day (low ADG) will require twice as many days to reach the finisher production stage than a grower pig with a growth rate of 688 g/day (Standard ADG). It amounts to 48 days of additional feeding required for the low ADG farm to produce a finisher pig. South African commercial pig farms' feed costs amount to approximately 70% of the total production costs (interview with Simon Streicher as discussed in Louw et al., 2011). Therefore, it is crucial for a pig farm to achieve high ADG levels.

Pig genetics have substantially improved over the last 10 to 20 years. A particular focus has been placed on the growth genetic trait. Growth rate is considered as a good trait for breeding selection because it can be accurately measured on the growing pig prior to breeding age. Growth rate has an approximate heritability (superiority of the parent animals is passed to their progeny) of 30%. The progeny of a crossbred sow, as opposed to purebred progeny, can achieve a 5 to 10% faster growth rate if the sire is not the same breed as one of the mother's parents (McPhee, 2001; Rothschild & Ruvinsky, 2011).

Feed conversion ratio

The feed conversion ratio (FCR) refers to the ratio between the amount (kg) of feed consumed and the amount (kg) of live weight gain (Oosterwijk, et al., 2003). The FCR is highly dependent on the feed's nutrient density, the breed's genetic potential, water availability, ambient temperatures and the sex type (male, female or castrate) (Kyriazakis & Whittemore, 2006).

A study by the Institut du Porc evaluated the FCR differences between boars, gilts and castrates from weaning until slaughter. Between the ages of 28 to 63 days, growth performance was not significantly influenced by the gender. However, between 63 and 152 days of age, the daily feed intake of boars was lower than that of castrates (2.41 and 2.70 kg/day, respectively). Their average daily gain was similar and not significantly different (1032 and 1069 g/day, respectively). Consequently, castration was associated with an increase of feed conversion ratio (2.62 compared to 2.26). Gilt feed conversion ratio (2.48) was intermediate between those of boars and castrates (Quiniou, et al., 2010).

FCR per production stage (Adapted from PIC, 2011):

- Weaner (8.25 to 25 kg live weight):
  - Marginal: 1.78.
  - Good: 1.72.
  - Target: 1.28.
- Grower (25 to 58 kg live weight):
  - Marginal: 2.27.
  - Good: 1.69.
  - Target: 1.61.
- Finisher (58 to 100 kg live weight):
  - Marginal: 3.75.
  - Good: 3.26.
  - Target: 2.68.
- Average (8.25 to 100 kg live weight):
  - Marginal: 2.85.
  - Good: 2.41.
  - Target: 2.04

Feed wastage is a major contributor to high FCR levels and, by extension, to high feed costs (Oosterwijk, et al., 2003). It can be reduced by adapting the feeding methods to the pigs' needs, behaviour and housing conditions.

2.3. Smallholder pig farming budgeting

This section entails the primary financial information that will be considered for the design of the commercial pig farming model.

2.3.1. Start-up costs

The start-up costs include the funding that will be required before commencing the pig farming operations of a new farm.

The principal start-up costs include:

- Land.
- Housing, infrastructure and equipment.
- Breeding stock.
- First year production costs.

Land

A plot of land is required for the construction of the pig facilities. Security of tenure is a vital consideration if permanent structures are to be erected (Swedish Cooperative Centre Africa & Agromisa, 2010).

Housing, infrastructure and equipment

The cost of commercial pig housing depends on various factors (McGlone & Pond, 2003; Kyriazakis & Whittemore, 2006) such as:

- Pig farm size: In terms of the number of production sows.
- Production system: Intensive, semi-intensive or extensive.
- Type of pig farm: Farrow-to-finish, farrow-to-wean or a grower unit.
- Mechanisation/automation level: Costs are increased if the design includes mechanical ventilation, an effluent disposal system and other forms of mechanisation.
- Infrastructure: Fencing, water and electricity supply, storage, workshop and office.
- Quality of materials: High quality materials can only be obtained at a premium price.

Louw et al. (2011) provide the following pig farm size categories:

Small:	Less than 401 sows.
Medium:	401 to 1 000 sows.
Large:	More than 1 000 sows.

Expansion planning must be incorporated in the design of a piggery, even if the possibility of expansion is remote (Kyriazakis & Whittemore, 2006; Commodico Distributors (Pty) Ltd., 2008).
The following sources discuss the estimated cost of pig housing, infrastructure and equipment:

1. Streicher (interview with Simon Streicher as discussed in Louw et al., 2011) considers the cost of erecting a pig facility as one of the largest entry barriers to commercial pig farming. Housing, infrastructure and equipment amount to an estimated cost of R 25 000 (non-mechanised) to R 40 000 (mechanised) per sow.
2. Casidra's estimated housing, infrastructure and equipment costs for a 20 sow pig farm (non-mechanised) is R 39 417 per sow (Personal communication, A. Otto, Casidra Project coordinator: Technical (Paarl), 31 October 2011).
3. A 100 sow pig farm business plan, compiled by Commodico Distributors (Pty) Ltd. (2008) on behalf of the SAPPO, has an estimated housing, infrastructure and equipment cost of between R 29 000 to R 35 000 per sow (mechanised).

The three housing budgets have relatively similar maximum costs per sow. However, the costs are based on three different types of facilities and pig farm sizes. The average cost of housing, infrastructure and equipment per sow is assumed to decrease as the size of the farm increases. The decrease is attributed to economies of scale and shared resources (such as equipment). In contrast, smaller pig production units require less automated equipment (self-feeders) and labour-reducing infrastructure (floor grating and waste disposal channels). The decreased infrastructure and equipment requirements reduce the overall housing, infrastructure and equipment costs per sow for small pig farms.

Breeding stock

Breeding stock is chosen according to its adaptability to the preferred housing system and the region's weather, mothering abilities and the slaughter pigs' carcass quality (Swedish Cooperative Centre Africa & Agromisa, 2010). PIC South Africa recommends the Camborough 22 (C22) (25% Large White, 25% Landrace, 50% White Duroc) commercial crossbreed female for smallholder pig farmers in the Western Cape (Personal communication, A. De Villiers, PIC South Africa Technical Adviser (Kanhym Estates), 3 November 2011). The C22's docile temperament, exceptional mothering ability, long working life, resilience, high prolificacy and good carcass quality makes it an ideal choice. The C22 sow's (terminal cross) offspring cannot be used to replace the herd's breeding stock. The estimated cost for a pregnant C22 sow is R 4 000. The cost includes transport to Malmesbury (Personal communication, J. Gouws, PIC South Africa Technical Adviser (Kanhym Estates), 15 November 2011). A breeding boar can be bought at an average cost of R 7 000. The cost of a stimulation boar (required for artificial insemination pig farms) is significantly less than the cost of a breeding boar (natural mating pig farm) and will amount to approximately R 3 500 per boar (Commodico Distributors (Pty) Ltd., 2008; Personal communication, H. Cronje, Owner and manager of Sweetwell Farm & Butchery, 14 June 2010).

First year production costs

In Section 2.2.1, the average gestation period is stated to be 115 days and the farrow-to-slaughter time is stated to be 111 to 168 days. Therefore, when a new farm that procures pregnant sows as breeding stock commences operations, it will require 226 (115 days + 111 days) to 283 days (115 days + 168 days) before the first pigs are slaughtered and an income is received. Feed and other supplies will be required during this time period. Therefore, the first year's production costs need to be included in the calculation of start-up costs.

2.3.2. Income

The revenue generated by the sale of slaughter pigs depends primarily on the number of slaughter pigs produced per year, the carcass weight, and the pork price (which in turn depends on the carcass classification).

Gross income (R)
= Pigs (#) x Carcass weight (kg) x Pork price (R/kg)

This section provides more detail on the variables associated with the income calculation. The number of slaughter pigs produced per year is omitted because it is discussed in Section 2.2.2 (Production performance).

Carcass weight

The carcass weight is calculated by considering the estimated dressing percentage of the slaughter pig at a specific live weight. Table 2.2 shows the median dressing percentage for slaughter pigs at eight different live slaughter weights.

Table 2.2 The dressing percentage of eight different live slaughter weights

Live slaughter weight (kg)	Median dressing percentage (%)
62	75.12
78	77.59
86	77.76
102	77.13
113	78.28
128	78.57
133	78.37
146	79.01

Source: Pieterse, 2006, p.53

The dressing percentage is affected by the sex type of the pig, slaughter weight and the genotype of the slaughter pig (Pieterse, 2006). Kyriazakis & Whittemore (2006) state that the average live weight at slaughter of United Kingdom farmers' pigs is 90 to 100 kg. According to Table 2.2, a 90 kg live slaughter weight finisher has an approximate dressing percentage of 77.76% (dressing percentage at 86 kg live weight) and the 100 kg finisher has an approximate dressing percentage of 77.13% (dressing percentage at 102 kg live weight). Therefore, the 90 kg live weight pig has an estimated carcass weight of 69.98 kg (77.76% x 90 kg) and the 100 kg live weight pig has an estimated carcass weight of 77.13 kg (77.13% x 100 kg).

Pork price

The pork price refers to the price received per kg of carcass weight. Pork prices are greatly reduced for a carcass with a suboptimal carcass classification. The pork quality is determined by the type of feed (nutrient specification), genetics, management and handling (Kyriazakis & Whittemore, 2006).

Factors that determine the quality of pork include (Kyriazakis & Whittemore, 2006, p. 511):

- Food safety: Microbiological safety (absence of *Salmonella*, *Campylobacter* and other bacteria or viruses) and residue safety (absence of antibiotics, heavy metals and other potentially harmful residues).
- Technological quality: Uniformity, consistency, pH, water holding capacity, firmness of fat, meat without tissue separation and oxidative stability.
- Eating quality: Colour, tenderness, juiciness, flavour, smell, visual fat quantity and marbling.
- Nutritional value: Fat content, fatty acid profile, protein content and nutrient enrichment.
- Social value: Animal welfare and the environmental friendliness of pig production.

South African pork carcasses are classified as Weaners, Class P to S (P, O, R, C, U or S), Sausage or Rough. Class descriptions (Bruwer, 1992):

1. Weaners: A carcass weight of 20 kg or less.
2. Class P to S: A carcass weighing more than 21 kg, but less than or equal to 100 kg (Pieterse, 2006), is classified according to the percentage of carcass lean meat. The classes' lean meat percentage ranges from Class P (highest) to Class S (lowest). Two different categories are applicable: Porkers (Carcass weight of 21 to 55 kg) and Baconers (Carcass weight of 56 to 100 kg).
3. Sausage: A carcass weight of more than 100 kg (Pieterse, 2006).
4. Rough: Old boar's carcass, carcass conformation score of 1, indicating genetic inferiorities, an overly thin carcass, a skin that is thick and coarse or a carcass that is fat or excessively oily.

Generally, high quality pork production requires higher production costs, but a higher price per kg carcass weight is received for the increased carcass quality. Several different types of market are available for the sale of slaughter pigs (Department of Agriculture, 2011):

- Abattoirs: Producers can sell their pigs, at a fixed price, directly to an abattoir. A contract allows the producer to sell the pigs at a stable, negotiated price for a specified period of time.
- Agents, distributors or wholesalers: These intermediaries facilitate the arrangements at the abattoir on the producers' behalf.
- Informal market: An informal market is available for smallholder pig farmers (predominantly situated in rural areas) to sell their lower (compared to commercial pig farms) quality pigs. The informal market is characterised by the consumer visiting the farm, buying a pig and then slaughtering the pig without making use of a registered abattoir.

The difference between porkers and baconer pork prices is shown in Figure 2.2.

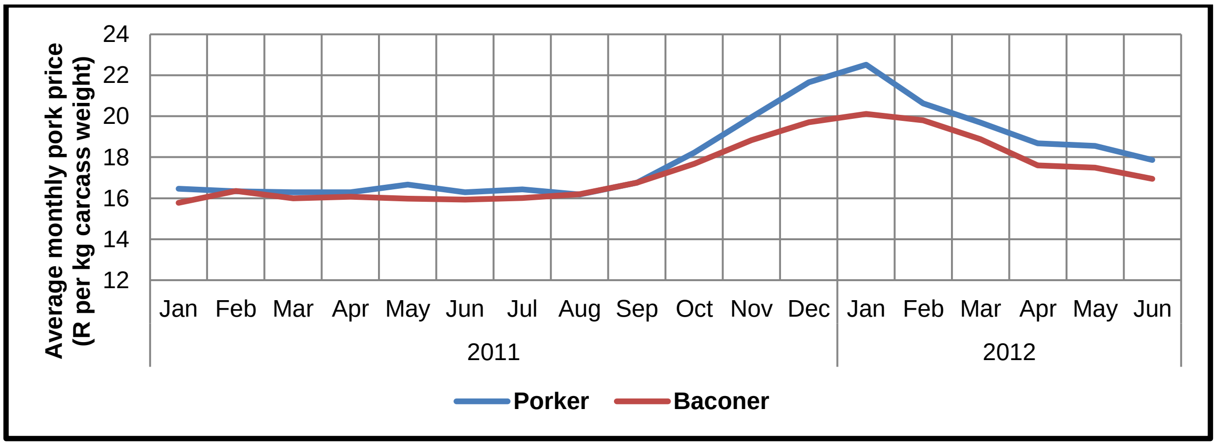


Figure 2.2 South African historic average monthly porker and baconer prices

Source: First National Bank, 2012

The difference between porker and baconer prices ranges between extremes of R 2.41 per kg (January 2012) and R 0 (August and September 2011) (First National Bank, 2012). Generally, pork prices decline during the months of April to August and increase during the festive or "braai" seasons (Department of Agriculture, 2011).

The average pork prices from July 2011 to June 2012:

Porker:	R 18.93 per kg (First National Bank, 2012).
Baconer:	R 18.00 per kg (First National Bank, 2012).
Sausage pig:	R 12.01 per kg (Red Meat Industry Forum, 2012).

The average pork prices compensates for the range of quality variances.

2.3.3. Production costs

Production costs include all the primary fixed and variable costs of pig farming operations.

Feed costs

South African commercial pig farms' feed costs amount to approximately 70% of the total production costs (interview with Simon Streicher as discussed in Louw et al., 2011). Nutritionally balanced, grain-based rations serve as feed for commercially raised pigs. Most South African commercial pig farmers (75%) source raw materials to mix their own pig feed. The rest (25% and concentrated in the Western Cape and Kwazulu-Natal) purchase prepared commercial feeds. The latter pig farmers purchase the prepared pig feeds primarily because of a lack of maize and other essential raw feed materials in their respective provinces (South African Pork Producers Organisation, 2009). If the farmer mixes his own feed, the operation will require additional machinery, labour, pig nutrition expertise and raw feed materials. The knowledge to formulate balanced diets is a necessity and it is only obtained through specific tertiary education (Kyriazakis & Whittemore, 2006; Phengsavanh, et al., 2011). Self-mixing is not considered as a viable option for smallholder pig producers because of the high cost of buying small quantities of raw materials and the necessity of having pig nutrition expertise.

The following two Western Cape feed suppliers provide examples of potential feed costs:

- Meadow Feeds in Paarl, Western Cape (Personal communication, L. Heramb, Meadow Feeds Sales & Business Development Officer (Paarl), 09 November 2011; H. Miller, Meadow Feeds Sales Assistant (Paarl), 12 December 2011).
- Nova Feeds in Malmesbury, Western Cape (Personal communication, S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011).

Consider Table 2.3 for Meadow Feeds' pricelist.

Table 2.3 Meadow Feeds' pricelist

Production stage	Meal (Per ton)*	Pellets (Per ton)*
Piglets	R 6 757	R 6 807
Weaners	R 4 321	R 4 371
Growers and finishers	R 3 482	R 3 532
Boar & dry sow	R 3 340	R 3 390
Lactating sow	R 3 622	R 3 672

* Prices exclude VAT and include delivery costs.

Source: Personal communication, L. Heramb, Meadow Feeds Sales & Business Development Officer (Paarl), 09 November 2011; H. Miller, Meadow Feeds Sales Assistant (Paarl), 12 December 2011

Potential discounts include (Personal communication, H. Miller, Meadow Feeds Sales Assistant (Paarl), 12 December 2011): A discount of R 30 per ton is applicable for early orders (orders received two working days in advance of delivery) and a 0.75% discount on the total order price for “cash before order” (CBO) or 0.60% discount on the total order price for payments within the month of delivery. Table 2.4 shows a calculation for Meadow Feeds’ feed cost (including delivery) to produce a 100 kg live weight pig. The daily feed amounts are recommended by Meadow Feeds (Personal communication, J. van Zyl, Meadow Feeds Nutritionist: Monogastric (Paarl), 07 November 2011).

The days per growth stage is based on Table 2.1. The piglets do not require feed for the first 14 days after birth (Section 2.2.1).

Table 2.4 Meadow Feeds’ feed costs to produce a 100 kg live weight pig

Production stage	Feed period per production stage (days)	Daily feed (kg)	Feed cost (R/kg)*	Cost (R/production stage)
Piglet	14	0.06	R 6.73	R 5.65
Weaner	42	1	R 4.29	R 180.18
Grower	48	1.5	R 3.45	R 248.40
Finisher	50	2.5	R 3.45	R 431.25
Total (no discount)	154			R 865.48
0.75% (CBO discount)				R 6.49
Total (with discount)				**R 858.99**

* Feed costs are based on Meadow Feeds’ bulk meal prices.

Consider Table 2.5 for Nova Feeds’ pricelist.

Table 2.5 Nova Feeds’ pricelist

Production stage	Live weight (kg)	Meal bulk (Per ton)*	Pellets bulk (Per ton)*
Piglets	Up to 9	R 6 590	R 6 640
Weaners	9 to 12	R 6 590	R 6 640
Weaners	12 to 25	R 3 900	R 3 950
Growers	25 to 30	R 3 900	R 3 950
Growers	30 to 50	R 3 500	R 3 550
Growers	50 to 60	R 3 440	R 3 490
Finishers	60 to 70	R 3 440	R 3 490
Finishers	70 to 100	R 3 080	R 3 130
Boar & dry sow	Not applicable	R 3 060	R 3 150
Lactating sow	Not applicable	R 3 510	R 3 560

* Prices exclude VAT and include delivery costs.

Source: Personal communication, S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011

Discounts are negotiated between Nova Feeds and the pig farmer (Personal communication, S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011). No discounts are considered for the Nova Feeds cost calculation, because no general discounts are available. Table 2.6 shows a calculation for Nova Feeds' feed cost (including delivery) to produce a 100 kg live weight pig. The daily feed amounts are recommended by Nova Feeds (Personal communication, S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011). The days per growth stage and weight group are based on Table 2.1. The piglets do not require feed for the first 14 days after birth (Section 2.2.1).

Table 2.6 Nova Feeds' feed costs to produce a 100 kg live weight pig

Production stage	Live weight (kg)	Feed period per production stage (days)	Daily feed (kg)	Feed cost (R/kg)*	Cost (R / production stage)
Piglet	4.86 to 8.25	14	0.06	R 6.59	R 5.54
Weaner	8.25 to 12	9	1	R 6.59	R 59.31
Weaner	12 to 25	32	1	R 3.90	R 124.80
Grower	25 to 30	7	1.5	R 3.90	R 40.95
Grower	30 to 50	29	1.5	R 3.50	R 152.25
Grower	50 to 60	15	1.5	R 3.44	R 77.40
Finisher	60 to 70	12	2.5	R 3.44	R 103.20
Finisher	70 to 100	36	2.5	R 3.08	R 277.20
Total		**154**			**R 840.65**

* Feed costs are based on Nova Feeds' bulk meal prices.

Feed costs to produce a 100 kg live weight pig is R 858.99 for Meadow Feeds (with discounts) and R 840.65 for Nova Feeds (without discounts). Additional discounts are possible, such as a 5% discount on feed costs for cooperatives, but neither of the feed supply companies is able to discuss potential discounts (except for the already discussed Meadow Feeds discounts). The only information they are able to divulge is that discounts are based on negotiation (Personal communication, L. Heramb, Meadow Feeds Sales & Business Development Officer (Paarl), 09 November 2011; H. Miller, Meadow Feeds Sales Assistant (Paarl), 12 December 2011; S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011).

The following factors influence the potential discount rate (Personal communication, L. Heramb, Meadow Feeds Sales & Business Development Officer (Paarl), 09 November 2011; H. Miller, Meadow Feeds Sales Assistant (Paarl), 12 December 2011; S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011):

- The frequency and tonnage of feed orders.
- Long term feed supplier contracts.
- Customer affiliation (such as educational institutions).
- Sales to emerging farmers and cooperatives.

Refer to Figure 2.3 to view the average monthly yellow maize price per ton.

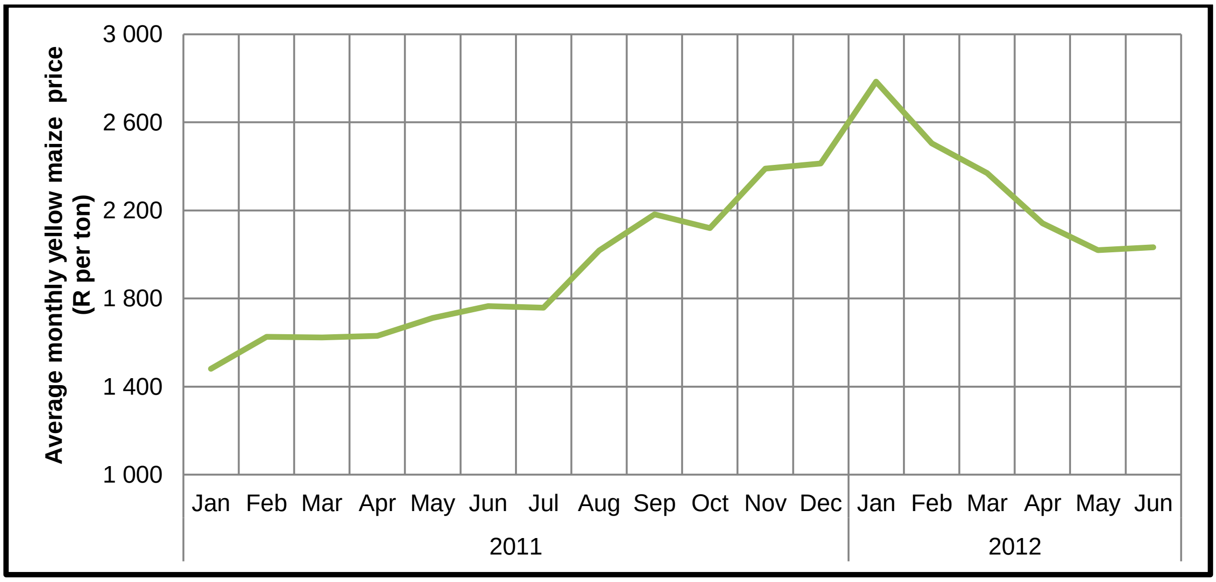


Figure 2.3 South African historic average monthly yellow maize prices

Source: First National Bank, 2012

The yellow maize price per ton reached a low of R 1 481 in January 2011 and a high of R 2 784 in January 2012. Approximately 60% of Meadow Feeds (Table 2.3) and Nova Feeds (Table 2.5) costs are directly related to the cost of yellow maize (Personal communication, L. Heramb, Meadow Feeds Sales & Business Development Officer (Paarl), 09 November 2011; S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011). The average yellow maize price per ton for November 2011 was R 2 389 (First National Bank, 2012). The average yellow maize price per ton from July 2011 to June 2012 was R 2 228.

Therefore, to convert the feed costs to an annual average, the current feed costs (November 2011) needs to be adjusted (Personal communication, L. Heramb, Meadow Feeds Sales & Business Development Officer (Paarl), 09 November 2011; S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011).

Current to annual feed costs adjustment calculation

= [Yellow maize costs as a percentage of feed costs] x
(1 – [Average annual yellow maize price per ton] / [Current yellow maize price per ton]) %

= 60% x (1 - R 2 228 / R 2 389) %

= 60% x -6.74%

= -4.04% ~ 4%

Therefore, the average feed costs to produce a 100 kg live weight pig is:

- Meadow Feeds (with discounts): R 824.63 (R 858.99 x [100% - 4%]).
- Nova Feeds (without discounts): R 807.02 (R 840.65 x [100% - 4%]).

Additional factors that affect the feed costs determination is not considered in this study. Animal feed products are exempt from VAT (Personal communication, S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011; South African Revenue Services, 2011). Nutrition and feeding management is vital for pig production, because the productivity of a pig farm is closely related to the efficient supply of quality feed to the herd. Quality pork can only be produced with good quality feed and feeding management.

Veterinary supplies costs

Medicine and veterinary costs include vaccinations, supplements and any other medicine and treatments (Kyriazakis & Whittemore, 2006). Consider the following example of a potential vaccination and treatment programme (Personal communication, S. Davey, State veterinarian at Malmesbury state veterinary services, 10 November 2010; Personal communication, A. Groenewald, Veterinarian at Bergzicht Animal Hospital (Malmesbury), 10 November 2010; J. Jordaan, Cape Veterinary Wholesalers (Cape Town), 12 December 2011).

Sow vaccinations:

- Farrowsure+B - Parvo/Lepto/Erysipelas (R 763.75 for 50 x 5 ml im (intramuscular) dosages):
    - First dosage: 4 weeks before servicing.
    - Additional dosages: 2 weeks before every service.
- Scourmune C - E-Coli + Clostridium (R 634.50 for 50 x 2 ml sc (subcutaneous) dosages):
    - First dosage: 6 to 7 weeks before farrowing.
    - Additional dosages: 3 to 4 weeks before farrowing.

Piglet vaccination and injection:

- M+Pac Mycoplasma (R 111.63 for 100 x 1 ml sc/im dosages):
    - First dosage: At the age of 7 to 10 days.
    - Second dosage: 2 weeks after the first dosage.
- Ferdex 20% iron injection (R 176.25 for 25 x 1 ml dosages):
    - Time of dosage: At the age of 3 to 5 days.

Residual vaccination dosages must be discarded to prevent contamination if not used within a few days after the container is opened. This increases the cost of veterinary supplies. The only exception is iron injections (Personal communication, J. Jordaan, Cape Veterinary Wholesalers (Cape Town), 12 December 2011). Additional veterinary supplies costs are incurred if disease outbreaks (such as mange) were to occur.

Transport costs

Transport costs include all the expenses associated with the self-managed delivery of supplies to the farm (such as feed) and the cost of transporting the pigs to the abattoir. ABSA Vehicle Management Solution (Pty) Ltd. & the Automobile Association of South Africa (2011) provides the following framework for the calculation of the vehicle operating cost:

Vehicle operating cost (R/km)
= Fixed costs (R/km) + Running costs (R/km) x Running costs adjustment (%)

Fixed costs refer to the cost elements associated with the depreciation of the vehicle's value, comprehensive insurance and vehicle licensing. If that a farmer travels less than 10 000 km per year and the vehicle's second hand purchase price (including VAT) is approximately R 50 000, a fixed cost of R 1.57 per km is applicable (ABSA Vehicle Management Solution (Pty) Ltd. & the Automobile Association of South Africa, 2011).

Running costs refer to the maintenance (servicing, repairs, tyres and lubrication) and fuel costs.

Running costs (R/km)
= Fuel factor (litre/km) x Fuel price (R/litre) + Service costs (R/km) + Tyre costs (R/km).

If it is a light commercial vehicle (such as a "bakkie") with an engine capacity of 2 000 to 2 500 cc, the fuel factor is 0.111, the service costs is 0.3 R/km and the tyre costs is 0.15 R/km (ABSA Vehicle Management Solution (Pty) Ltd. & the Automobile Association of South Africa, 2011). The fuel price was R 9.81 per litre (diesel, 0.05% sulphur, coastal) on 02 November 2011 (Automobile Association of South Africa, 2011). Therefore, the running costs amount to R 1.54 per km (0.111 litre/km x 9.81 R/litre + 0.3 R/km + 0.15 R/km).

Running costs adjustments:

Fully loaded vehicles:	Running costs increase by 12%.
Single axle trailer attached:	Running costs increase by 8%.

Vehicle operating cost (R/km)
= Fixed costs (R/km) + Running costs (R/km) x Running costs adjustment (%)
= R 1.57 per km + R 1.54 per km x 100% (no load or trailer)
= R 3.11 per km

The transport cost can be calculated by using the vehicle operating cost, the running cost adjustment and an estimation of the distance travelled.

Utility costs

Utility costs include water and electricity charges (Dhuyvetter, et al., 2011).

Electricity is required predominantly for heating, but it is also required for lighting and for mechanised/automated equipment. The standard electricity tariff (2011) is R 0.52 per kWh (Eskom, 2011).

A piggery requires a large amount of water to achieve optimal production performance. Whittington (2005) found that a farrow-to-finish piggery uses an average of 78 litres of water per sow per day. However, the water requirement deviates between extremes of 65 to 120 litres of water per sow per day. Therefore, a 50 sow piggery will require an estimated 1 423.5 kilolitres of water per year (78 litres water x 50 sows x 365 days) or 118.625 kilolitres per month.

The water usage can be broken down according to the following activities (Froese, 2003):

Drinking:	80%.
Cooling:	12%.
Washing:	7%.
Domestic use:	1%.

The cost of water entails two elements: fresh water and sanitation (Saving Water SA, 2011). Table 2.7 shows the 2011 monthly tariff structure for fresh water consumption.

Table 2.7 Monthly fresh water cost structure

Monthly fresh water consumption range (kL)	Price per consumption range (R/kL)
0 to 6	R 0.00
6 to 10.5	R 4.92
10.5 to 20	R 10.51
20 to 35	R 15.57
35 to 50	R 18.99
50+	R 25.37

Source: Saving Water SA, 2011

As an example, consider the following monthly fresh water cost calculation for a 50 sow pig farm (118.625 kL water consumed per month).

Monthly fresh water cost

= 6 kL x R 0.00 + (10.5 - 6) kL x R 4.92 + (20 - 10.5) kL x R 10.51 + (35 - 20) kL x R 15.57 + (50 - 35) kL x R 18.99 + (118.625 – 50) x R 25.37

= R 22.14 + R 99.85 + R 233.55 + R 284.85 + R 1 741.02

= R 2 381.41

Sanitation is charged at a 70% consumption rate of fresh water and there is a limit of 35 kL charged per month (Saving Water SA, 2011). Table 2.8 shows the 2011 monthly tariff structure for sanitation.

Table 2.8 Monthly sanitation cost structure

Monthly sanitation range (kL)	Price per consumption range (R/kL)
0 to 4.2	R 0.00
4.2 to 7.35	R 5.05
7.35 to 14	R 10.76
14 to 24.5	R 11.77
24.5 to 35	R 12.36

Source: Saving Water SA, 2011

As an example, consider the 50 sow piggery's monthly fresh water consumption of 118.625 kL. The sanitation will be charged at a consumption level of 35 kL (70% x 118.625 kL is 83.03 kL but the maximum sanitation fee can be charge for 35 kL).

Monthly sanitation cost

= 4.2 kL x R 0.00 + (7.35 – 4.2) kL x R 5.05 + (14 – 7.35) kL x R 10.76 + (24.5 - 14) kL x R 11.77 + (35 – 24.5) kL x R 12.36

= R 15.91 + R 71.55 + R 123.59 + R 129.78

= R 340.83

Total estimated monthly water cost for a 50 sow piggery

= Monthly fresh water cost + Monthly sanitation cost

= R 2 381.41 + R 340.83

= R 2 722.24

The fresh water and sanitation charges are based on Mamre's domestic water rates. Lekubu (Personal communication, L. Lekubu, Regional coordinator, Department of Water Affairs - Western Cape, 11 October 2012) states that Mamre's domestic water charges falls under the City of Cape Town's rates. The case study farms do not currently have a direct domestic or agriculture water supply. However, since Mamre already have a domestic water supply and because of the town's close proximity to the case study smallholder farms, a domestic water supply will be the most likely water supply option for the smallholder pig farmers.

The monthly fresh water and sanitation charges are provided at a discounted rate to subsistence farmers. However, a commercial pig farm will not be entitled to similar discounts (Personal communication, L. Lekubu, Regional coordinator, Department of Water Affairs (Western Cape), 11 October 2012). A commercial pig farmer can reduce the cost of water resources if he has access to dams, boreholes or an agriculture water supply. Schreuder (Personal communication, A. Schreuder, Western Cape Regional Office – Institutional Establishment, Department of Water Affairs - Western Cape, 10 October 2012) states that an agriculture water supply (charges 1.5 c/l) is available for the Berg Water Management Area. However, the case study smallholder pig farmers will not be able to access this water source in the near future because of their distance from the source. If the smallholder farmers were able access an agriculture water supply, their water charges will drastically reduce.

Breeding stock replacements

For F1 cross or Purebred breeding systems, the best gilts and boars (those that show the characteristics of being healthy and potentially good breeders) are kept to replace the older or culled breeding stock (McGlone & Pond, 2003; Kyriazakis & Whittemore, 2006).

For terminal cross breeding systems, breeding stock is replaced from outside the herd and all the offspring are destined for the market (McGlone & Pond, 2003; Kyriazakis & Whittemore, 2006). The cost to buy replacement breeding stock is similar to the initial breeding stock prices (Section 2.3.1).

Artificial insemination costs

Artificial insemination requires a minimum of two services per sow per farrowing (Personal communication, A. De Villiers, PIC South Africa Technical Adviser (Kanhym Estates), 3 November 2011).

Artificial insemination costs per sow per farrowing
= 2 x R 52.00 (dosage cost) + 2 x R 4.60 (catheter cost)
= R 113.20

The following are factors that lead to artificial insemination (AI) being considered as superior to natural mating (Personal communication, A. De Villiers, Kanhym Estates, PIC South Africa, 19 August 2010):

- Reproductive performance: A study by Am-in et al. (2010) found that artificially inseminated sows have a higher farrowing rate than naturally mated sows (84% compared to 74%).
- Genetics: AI gives pig producers access to global superior sire line genetics (Am-in, et al., 2010). Performance measures include boars with offspring that have excellent feed conversion ratios, high average daily gains and good carcass quality.
- Lower quality and fewer on-site boars needed: Low quality, non-breeding boars are used for sow stimulation. The stimulation boars require lower quality feed than breeding boars. Boars are only kept on the farm for stimulation purposes. Therefore, fewer boars are required per servicing (a single boar can stimulate several sows). Fewer on-site boars mean that less housing and feed is required.

Living costs

A pig farm needs to a generate profit to provide a salary to the farmer and his household. The minimum living cost of a smallholder pig farmer's family can be represented by the Living Standards Measure (LSM). The LSM is a multi-attribute segmentation tool that is based on access to services and durables and geographic indicators as determinants of living standards. According to the SAARF's research, rural households received an income of between R 1 363 (LSM 1) and R 4 165 (LSM 5) per month (South African Advertising Research Foundation, 2012).

Labour costs

Labour requirements depend on the degree of automation on the farm (Kyriazakis & Whittemore, 2006). According to Spencer (2010), at least one person, with part-time labour, is required to operate a 150 sow piggery with an automated feeding system. Streicher (interview with Simon Streicher as discussed in Louw et al., 2011) states that 8 to 10 workers are required for a small pig farm (less than 400 sows) and more than 50 workers are required for a large pig farms (more than 1 000 sows).

The assumption is made that a single pig farmer with part-time labour will be required to operate a smallholder pig farm. The minimum farmworker wages, as set on 01 March 2011, is R 318 per week or R 1 376 per month (Department of Labour, 2011).

Maintenance, repairs and replacements

Maintenance costs refer to the repair and maintenance of housing, infrastructure and equipment. This production cost also includes the replacement of equipment (McGlone & Pond, 2003; Kyriazakis & Whittemore, 2006). Most pig farm equipment can last several years but some types of equipment (such as heating lamps) need to be replaced more than once a year. The price of a 175 Watt, 90% efficiency heating lamp (including fittings) with 5 000 hours lifetime cost R 211 (including VAT) (Personal communication, Schreck, W., Technilamp, 18 April 2012).

Maintenance budgeting examples:

- United Kingdom pig farm statistics show that maintenance and repair costs amounts to approximately 3.5% of the annual production costs (Kyriazakis & Whittemore, 2006).
- For a South African perspective, Commodico Distributors (Pty) Ltd. (2008) budgets R 9 000 per year (0.5% of the housing and infrastructure costs, as well as 0.5% of the annual production costs) for the maintenance and repair of a 100 sow pig farm’s housing, infrastructure and equipment.

Maintenance and repairs budgeting is highly dependent on the location and the infrastructure of the pig farm. This maintenance costs differences can be explained by the differences between regions in terms of maintenance labour and material costs and, additionally, because of the differences between the maintenance costs for automated/mechanised and non-automated pig production systems.

Other costs

Additional potential production costs (Kyriazakis & Whittemore, 2006; Dhuyvetter, et al., 2011):

- Additional supplies include disinfection/sanitation supplies and bedding.
- Interest on loans.
- Legal and accounting services.
- Office equipment and telephone fees.

2.3.4. Profit / Loss

Streicher (interview with Simon Streicher as discussed in Louw et al., 2011) states that sustainable South African commercial piggeries achieve a profit margin of 10% to 15%. A profit margin of less than 10% are inclined towards risk and a profit margin of more than 15% is considered as exceptionally good. Experts state that the minimum size of a profitable pig production unit is between 50 sows (Personal communication, Q. Nyoka, SAPPO’s Portfolio Committee for Emerging Farmers, 6 August 2010) and 100 sows (Personal communication, J. Robinson, Private veterinary consultant, 05 December 2010).

The reasoning for a minimum unit size is because of economies of scale benefits (such as feed cost discounts by purchasing feed in bulk). However, it is potentially possible for smallholder pig farmers, with farm sizes of less than 50 sows, to be profitable (Lapar & Staal, 2010; Petrus, et al., 2011; Phengsavanh, et al., 2011). Feed can be sourced from local feed suppliers to reduce transport costs and an optimal income can be achieved if the pig production performance is on par with large-scale operations.

2.4. Smallholder pig farming challenges

Smallholder pig farmers experience various challenges that impede them from achieving a commercially viable pig production performance level. This section discusses their numerous challenges and potential solutions.

2.4.1. Feed

Feed is arguably the most important pig farming input and its importance is rivalled only by drinking water (McGlone & Pond, 2003; Kyriazakis & Whittemore, 2006). However, most smallholder pig farmers, throughout the world, lack the funds to procure sufficient quantities of adequate quality feed. Feeding costs are high because of the high transport costs associated with the long distances to the feed suppliers and the rural regions' poor road infrastructure (Nompozolo, 2000; Mtileni, et al., 2006; Ajala, et al., 2007; Kagira, et al., 2010). Additionally, smallholder pig farmers lack the scale of operations to secure bulk discounts from feed suppliers (Costales, et al., 2007; Lapar & Staal, 2010).

Consequently, smallholder pig farmers use swill feed as an affordable feed source. Swill feed refers to animal matter (meat, feathers, and faeces) as well as fruit and vegetable scraps. Generally, swill feed is sourced from kitchen waste (restaurants, prisons and homes). Pigs should never be fed with swill feed because it can lead to disease transfer. The *Salmonella*, *Campylobacter*, *Foot-and-mouth disease (FMD)* and *Classical Swine Fever (CSF)* are able to survive in processed meat products (Turton, 2002; Beltrán-Alcrudo, et al., 2008). Pigs receiving swill feed are not accepted for slaughter in South African abattoirs.

Additionally, pigs do not receive sufficient energy, protein, minerals and vitamins when fed with swill. Pig malnutrition has the following effect on the herd (Mtileni, et al., 2006; Ajala, et al., 2007; International Livestock Research Institute, 2011):

- Performance losses: Slower growth rate and lower reproduction potential.
- Decreased marketability: Lower carcass quality and non-uniform growth.
- Poor health: Increased mortality rate and susceptibility to diseases.

2.4.2. Water

It is imperative for pig farmers to ensure that sufficient water of adequate quality is available to their pigs. If the pigs should consume insufficient amounts of water, their health and growth will be adversely affected. Manona (2005) (South Africa) and Chiduwa et al. (2008) (Zimbabwe) states that a lack of water is one of the most dire constraints to profitable smallholder pig farming. In Chiduwa et al.'s 2008 study, eight out of 32 surveyed pig farmers did not have direct access to water resources. The water resource poor farmers experienced 28% higher piglet mortalities compared to the farmers with direct access to water. The primary reason for smallholder pig farmers' inability to access water resources is because of the lack of infrastructure in rural areas. Rainwater collection can provide an additional water supply. Rainwater is collected by means of a pipe that relays water from the pig housing roof's gutters to water storage tanks or by means of pond-like structures. It is important to filter or decontaminate the water before it is consumed (Saha, et al., 2007).

2.4.3. Funding

Regional initiatives can offer markets and funding to smallholder pig farmers. As an example, the Philippi Market (Western Cape) aims to procure 75% of their pork supplies from smallholder commercial farms by 2012. This can lead to government financial support to the smallholder agriculture sector of more than R 50 million per annum (City of Cape Town, 2006; PLAAS, 2011).

2.4.4. Housing

Profitable pig farming requires suitable housing for each of the production stages. Pigs need warmth (piglets and weaners), dry bedding, adequate floor space and protection from the extreme temperatures during winter and summer (Mtileni, et al., 2006). Smallholder pig farmers can achieve a higher production performance level if they have access to proper pig housing (Chiduwa, et al., 2008). However, smallholder pig farmers are unable to afford the construction and maintenance of pig production facilities (Louw, et al., 2011). The primary smallholder pig farming housing challenges include the following.

Inadequate space allowance

Generally, smallholder pig farmers' pens do not adhere to the minimum space allowances for feeding, drinking, movement and lying down for the different pig production stages (Nompozolo, 2000; Ajala, et al., 2007). The determental effect of this practice is proven in a study by Hamilton et al. (2003) that consisted of 736 pigs, half with restricted floor space (0.37 m^2 per grower and 0.56 m^2 per finisher) and the other half with unrestricted floor space (0.93 m^2 per grower/finisher). Findings showed that the pigs that were housed on restricted floor space had a lower ADG as well as a higher FCR than the unrestricted pigs.

Additionally, proper feeder design for each production stage can improve the pig farm's FCR levels (Kyriazakis & Whittemore, 2006). In a study by the Prairie Swine Centre, weaners were provided feed in feeders with five different feeder gap openings (ranging from 9.2 to 31.5 mm) for 42 days (commencing eight days post-weaning). During days 21 to 42, body weight, ADG and the average daily feed intake increased with as the feeder gap size increased. By day 42, the pigs in pens with the widest feeder gap weighed 10% more than pigs in pens with the smallest gap. The ADG over the entire experimental period (0 to 42 days) was 480 g/day when the feeder gap opening was 9.2 mm and 532 g/day when the feeder gap opening was 31.5 mm. Therefore, a larger feeder gap opening was associated with greater body weight at day 42 (Smith, et al., 2004).

Therefore, it is vital to provide sufficient floor space and proper feeder design for optimal pig production performance.

Lack of equipment

A lack of farrowing equipment and creep areas leads to an increased rate of piglet mortality by sow crushing (Andersen, et al., 2005).

Ventilation

Proper ventilation is needed to provide optimum climatic conditions and a fresh air supply (Kyriazakis & Whittemore, 2006).

Separate housing

Diseases (such as *Swine Influenza, Porcine Respiratory and Reproductive Syndrome (PRRS)* and *Mycoplasma hyponeumoniae*) can spread from the larger pigs to the younger pigs when pigs of different ages share the same air space. High production performance losses will be the result from an outbreak. Different buildings are recommended for different growth stages to prevent the spread of disease (Kyriazakis & Whittemore, 2006, p. 270; Waddilove, 2008).

2.4.5. Heating

In a study of 135 commercial smallholder farmers in Transkei (Eastern Cape), only 15% reported having access to electricity (Nompozolo, 2000). A lack of electricity translates to a lack of affordable heating and high piglet mortalities are observed on farms with insufficient or no heating (Pluske, et al., 2003; Kyriazakis & Whittemore, 2006).

Solar power presents a potential opportunity to smallholder pig farmers that do not have access to a direct electricity supply. Table 9.1 shows three quotations for solar systems that can power a single 175 Watt heating lamp for 12 or 24 hours per day. The lowest quotation is R 58 986 for 24 hours operation and R 32 219 for 12 hours operation (Personal communication, Hüllermeier, K., Sinetech, 3 March 2011). The cost to power more than one 175 Watt heating lamp increases linearly as the number of heating lamps increases. The primary concern with solar power is the high initial cost to compensate for night time and lay-over (low solar conditions) days as well as replacement costs (batteries are replaced after 5 to 10 years) (Personal communication, Du Plessis, E., Sunflare, 7 March 2011; Hüllermeier, K., Sinetech, 3 March 2011; Lee-Wright, A., Sustainable.co.za, 8 March 2011). Solar power equipment costs will reduce as the technology improves. However, it is currently too high for smallholder pig farm heating purposes.

Another heating opportunity can be found in biogas production. Confined housing ensures that the pig farmer will have a steady supply of manure and effluent concentrated in a relatively small area. The manure and effluent can be used to produce methane (biogas) as well as to fertilise vegetable gardens. Biogas provides a renewable, clean and natural source of energy. The gas is produced by an anaerobic biological conversion process that is fed by biological matter (such as manure, urine and other organic residues) (Cilliers, 2006). Biogas can be used as a fuel source for cooking (Cilliers, 2006), heating (Cilliers, 2006) and to generate electricity (Moser, et al., 2005). It can provide numerous additional benefits to a smallholder pig farmers such as odour control, pathogen destruction and a reduction in waste pollutant levels (Cilliers, 2006).

However, the following must be kept in mind when biogas is used (Cilliers, 2006; Herrero, 2011):

- Inconsistent production rate: The biogas production rate is highly dependent on the availability of pig manure as well as ambient temperatures (biogas producing bacteria require temperatures in the range of 35 to 40 °C for optimal production).
- Water requirements: Biogas production requires 0.8 to 1.5 litres of water for every kilogram of raw, undigested manure.
- Fire hazard: Biogas leakage poses a potential fire or explosive hazard.

Cilliers (2006) states that it is theoretically possible for a pig farm to produce sufficient biogas for the herd's piglet and weaner heating requirements, but the cold temperatures during winter months severely reduce the production rate. Large pig farms, with a large supply of manure and effluent, have a higher potential than smallholder pig farms to use biogas as a fuel source to complement electricity powered heating.

2.4.6. Pig production expertise

Mtileni et al. (2006) and Kagira et al. (2010) state that smallholder pig farmers' success is hampered by their limited schooling and pig production training. Additionally, there is a distinct lack of pig production information available at the education level and language of smallholder pig farmers.

Specific smallholder pig production management issues include:

- A lack of disease identification skills (Kagira, et al., 2010)**.**
- Delayed weaning (Kagira, et al., 2010).
- Inbreeding (Petrus, et al., 2011).
- Smallholder pig farmers rarely know how much their pigs are worth. This leads to exploitation (International Livestock Research Institute, 2011).
- Inconsistent product because of unstructured pig rearing methods (International Livestock Research Institute, 2011).

The lack of pig production skills can be addressed by providing training (financial, pig life cycle management, biosecurity measures, how to target markets and proper feeding methods) and on-site or regional support (extension services) to smallholder pig farmers (Nompozolo, 2000; Maharjan & Fradejas, 2006; Ajala, et al., 2007). Several South African organisations, such as the Agricultural Research Council (ARC) (Agricultural Research Council, 2008), SAPPO (Louw, et al., 2011) and educational institutions throughout South Africa offers or facilitate free training and support to smallholder farmers.

2.4.7. Biosecurity

In 2004 and 2007, the unpredictability of diseases entering South African pig herds was exemplified by outbreaks of *Porcine Respiratory and Reproductive Syndrome (PRRS or "blue ear")* in the Western Cape. *PRRS* spreads rapidly in a confined pig herd and causes substantial losses to piggeries because of increased mortalities, abortions and still-births (Robinson, 2004; Robinson, 2009).

Both outbreaks were eliminated by the combined effort of the Western Cape Veterinary Services, members of the Pig Veterinary Society, South African Pork Producer's Organisation (SAPPO), the Western Cape Agriculture Department, the Provincial Disaster Committee, the South African army and the police (Robinson, 2009). Producers who were not affected by the outbreaks are nevertheless engaged in a daily battle against common diseases that cause production losses (Robinson, 2004; Robinson, 2009).

SAPPO encourages pig farmers to adhere to the minimum biosecurity standards. These standards, in brief, include the following (Nyoka, 2009):

- Abnormal mortalities must be reported within 24 hours.
- Clean protective clothing and gumboots should be the standard on-site attire.
- Controlled access on a well-fenced farm. Vehicles must be parked outside the fenced area.
- Records need to be maintained regarding the birth, death and movements of the entire herd.
- Sick employees may not enter pig facilities.
- The disposal of dead animals must be documented.
- Each pig needs to be marked by an ear tattoo.
- The farm must have a pest control plan.
- The biosecurity levels need to be verified by a pig health expert.
- The use of swill feed is illegal for commercial producers.
- Up-to-date clinical records must be kept.
- When using AI, semen must be sourced from biosecure farms.

The Winelands Pork abattoir, in Bellville (Cape Town) and the Roelcor abattoir (Malmesbury), adhere to the strict requirements of the Meat Safety Act 40 of 2000. Their slaughter pig suppliers must adhere to the following minimum specific minimum requirements.

The minimum requirements are (Personal communication, L. Verster, Winelands Pork Procurement manager, 4 November 2011; L. Bothma, Roelcor Abattoir manager (Malmesbury), 4 November 2011):

- Castration is not allowed.
- No swill feed is allowed and no traces of melamine are allowed in the pig feed. A balanced diet must be followed.
- The farm must be free of any traces of the following diseases: *CSF, PRRS* and *FMD*.
- The minimum withdrawal time of antibiotics before slaughter must be more than 30 days.
- The pig farm must at least have standard biosecurity compliance (similar to the SAPPO biosecurity guidelines (Nyoka, 2009)) and the farm must be visited at least once a month by a veterinarian to ensure that the pigs, housing and feed adhere to the necessary requirements.

Generally, smallholder pig farmers do not adhere to all the commercial pig farming biosecurity requirements (Wabacha, et al., 2004; Ajala, et al., 2007; Costard, et al., 2009; Uaboi-Egbenni, et al., 2011).

2.4.8. Marketing

Most smallholder pig farmers do not have access to sustainable markets. When the farmer does not consume his own pigs (subsistence farming), he generally sells them at informal markets or to prospective buyers at varying, usually low, prices. The prices are not linked to a classification system (pigs are rarely weighed) (Mtileni, et al., 2006; Petrus, et al., 2011). Additionally, pork quality is affected by the long distance to the market on low quality roads in rural areas (Nompozolo, 2000).

The following factors can affect market demand (Directorate Marketing, 2010c):

- International competition: Imports from countries where pigs can be produced at a lower cost flood the South African market and lowers the demand for local pork products. If a large volume of pork products is imported, the domestic price can be forced down.
- Local competition: The demand for a specific producer's pigs will decrease as the number of producers increases unless the market demand also increases.
- Pig disease outbreaks: Swine disease outbreaks reduce the demand for pork.

According to the Directorate of Marketing (2010c) and the Food and Agriculture Organisation of the United Nations (2010), imports, as a percentage of South African pork production, were approximately 9.86% in 2008. In 2008, the two countries that contributed the largest volume towards South African pork imports were France (35.1% of the total annual South African imports) and Canada (22.5% of the total annual South African imports) (Directorate Marketing, 2010c). The South African pork industry receives only minor protection, in terms of import duties, when compared to other livestock industries, such as the beef and mutton industries.

In 2008, the duty on imported meat products was:

- Pork: 15% of the import value or $ 196.70 per ton (R 1 524, the Rand to US Dollar exchange rate was R 7.75 per US Dollar in July 2010) - whichever is larger (Directorate Marketing, 2010c).
- Beef: 40% of the import value or $ 318.84 (R 2 471 in July 2010) per ton - whichever is larger (Directorate Marketing, 2010a).
- Mutton: 40% of the import value or $ 198.66 (R 1 540 in July 2010) per ton - whichever is larger (Directorate Marketing, 2010b).

Imports on this scale threaten local competitiveness and the conclusion can be drawn that South African competitiveness is detrimentally affected in the face of subsidised production in other countries (Louw, et al., 2011).

2.4.9. Security of tenure

Security of tenure is required for smallholder farmers to construct proper pig housing facilities. Smallholder farmers rarely own the land they farm on. Nompozolo (2000) found that out of 128 smallholder farms in Transkei, only 14 owned farm land, 50 farmed on leased land and 64 farmed on communal farms.

2.5. Literature study overview

The literature study provided an overview of the research approach as well the aspects (production performance, costing and perceived challenges) that require consideration for the design of the smallholder commercial pig production model. Subsequently, the model will be used to determine whether the proposed smallholder commercial pig farm can potentially be profitable and sustainable.

3. Methodology

The “Methodology” chapter discusses how the economic feasibility study, based on the case study, was conducted. The following steps are followed (as discussed in Section 2.1):

1. Problem statement.
2. Data gathering.
3. Analysis.
4. Evaluation.
5. Findings.

3.1. Problem statement

South Africa’s food insecurity challenge (fuelled by poverty and unemployment) are discussed in Chapter 1. The advancement of smallholder pig farms to a commercial standard is identified as a potential solution because of the numerous economic and food production benefits that the endeavour can offer to South Africa (Section 1.3). However, one needs to consider whether this endeavour will be profitable and sustainable on an individual pig farm basis.

Therefore, the research question (Section 1.4) asks: Is it economically feasible for a smallholder piggery to convert to a commercial standard?

3.2. Data gathering

The case study sample population is drawn from the Empolweni farming community that is situated near Mamre in the Western Cape. The information was collected by means of a structured questionnaire (completed by the pig farmer) or by the researcher (telephonic interview with the pig farmer). The data collection period ranged from 30 June 2010 to 30 August 2010. The questionnaire can be viewed in Section 9.2.

The sample population shared the following characteristics:

- The farmer produces pigs. However, pig farming does not have to be the only farming activity on the plot.
- The farmers consume their produced pigs (subsistence) and/or sell to the informal market. No commercial farms are included in the sample.
- Numerous pig farmers are present in the community, but only those that agreed to answer the questionnaires are included in the sample.

A total of seven pig farmers accepted the questionnaires. Of the seven farmers, four provided completed questionnaires to the researcher and three of the farmers answered the survey by means of telephonic interviews. Three ethnic groups are present: black (three farmers), coloured (three farmers) and white (one farmer).

The community's technical and production performances are scrutinised by regional pig health experts - two veterinarians (Personal communication, S. Davey, State veterinarian (Malmesbury), 10 November 2010; A. Groenewald, Veterinarian (Bergzicht Animal Hospital in Malmesbury), 10 November 2010) and an animal health technician (Personal communication, M. Vrey, Animal health technician (Malmesbury), 10 August 2010).

3.3. Analysis

The "Analysis" chapter (Chapter 4) provides an overview of the Empolweni community's pig farming operations in conjunction with the Empolweni pig farmers' production performance gaps (in relation to commercial pig farming operations). The production performance gap analysis is followed by an analysis of the costs, production planning and a commercial smallholder pig farm model design. Finally, the model is implemented in Microsoft (MS) Excel 2010.

The implemented model was validated by Mr John Morris (Personal communication, J. Morris, manager of the Mariendahl Experimental farm (Stellenbosch), 23 June 2011) and Mr Nico de Kock (Personal communication, N. de Kock, Department of Agriculture, Agricultural Economist - Farmer Support & Development (Malmesbury), 01 August 2011).

3.4. Evaluation

The "Evaluation" chapter (Chapter 5) uses the implemented model (in MS Excel 2010) to conduct a sensitivity analysis on several production performance scenarios. The model's parameters are linked to allow simultaneous variable adjustments (Section 9.2).

3.5. Findings

The "Findings" chapter (Chapter 6) involves a discussion of the sensitivity analysis' results and how they relate to the research question.

4. Analysis

The analysis chapter provides an overview of the Empolweni community's current pig production status. Subsequently, the current perceived production performance levels are compared to those of commercial pig farms to identify gaps and a means of improving current performance. Lastly, a base case model is designed to act as the starting point for the evaluation of the economic feasibility of the proposed endeavour (Chapter 5).

4.1. Case study community overview

The Empolweni community includes 60 smallholder farmers and their respective households. They are located along the Silverstream Road on the West Coast of South Africa. Mamre is located less than 6 km from the centre of the community. The smallholder farmers originate from the townships in and around Cape Town. They moved from an urban to a rural environment because of a lack of land, livestock theft and the danger that high traffic levels posed to their livestock. They do not own or lease the land and are considered as informal settlers by the local government. Farming is performed on separate pieces of land and activities include chicken, goat, pig and sheep livestock farming as well as small vegetable gardens.

The Empolweni farmers wish to improve their current informal, small-scale farming, aimed at feeding their families, to large-scale commercial farming that can provide more food to the South African population. Pig farming is considered as an important farming activity by at least seven of the community's farmers (Section 3.2). Their motivation for pig farming ranges from home consumption to income generation with sales to informal markets. Some of the farmers derive additional benefits from pig farming by composting the pig manure to produce fertiliser for their vegetable gardens.

The following subsections provide an overview of the community's current pig farming status as reported by seven Empolweni pig farmers (henceforth referred to as the respondents) and three regional pig health experts (Section 3.2).

4.1.1. Housing, infrastructure and equipment

The Empolweni community's pig housing materials include wooden pallets, planks and corrugated iron sheets for roof covers. Materials are obtained from nearby sources at a low cost or free of charge. All of the respondents have access to a vehicle to collect supplies or transport pigs. Mr Marius Vrey (Personal communication, M. Vrey, Animal health technician at Malmesbury state veterinary services, 10 August 2010), verified the response and stated that a substantial number of the community's households have access to a light pickup truck (bakkie).

Shortcomings of the case study's pig housing include:

- Floors: None of the structures have concrete floors. It is impossible for the farmers to disinfect soil surfaces effectively.
- Heating and equipment: None of the respondents have access to electricity or heating equipment, farrowing crates or crushing-prevention rails. Wood shavings, straw or leaves provide insulation from the pen's soil surface. Only two respondents said that they provide creep areas in their farrowing pens.
- Protection against the weather: Davey (Personal communication, S. Davey, State veterinarian at Malmesbury state veterinary services, 10 November 2010) states that the community's smallholder pig housing provides insufficient insulation against adverse weather conditions.
- Space allowance: The pens' space allowance is potentially too limited for the larger pigs (Personal communication, M. Vrey, Animal health technician at Malmesbury state veterinary services, 10 August 2010).
- Walls: The pens' wooden walls are not durable enough for pig housing because at least four of the seven respondents reported breakouts as a frequent occurrence.

4.1.2. Feed

The respondents provide quality feed to the piglets and swill feed to the larger pigs (Table 4.1).

Table 4.1 Feed supply details per production stage

Production stage	Materials	Preparation
Piglets	Growing pellets or meal.	Mixed with water.
Weaners	Growing pellets or meal, raw dog food materials and bran.	Mixed with water and some or all of the materials.
Growers, finishers, lactating and dry sows and boars	Growing pellets or meal, fruit and vegetables, raw dog food material, bran and pie dough.	Some or all of the various materials are mixed together with or without water.

Swill feed is used because it is inexpensive and easy to obtain. Only two of the respondents are aware of the dangers of swill feed.

4.1.3. Water

The respondents do not have direct access to a municipal water supply and two of the respondents' nearest water source (a central water tank) is located approximately 4 km from their farm. The water tank is refilled every week by the municipality and the water is free of charge. Low herd health and production performance is the consequence of the inconsistent water supply (Personal communication, S. Davey, State veterinarian at Malmesbury state veterinary services, 10 November 2010).

4.1.4. Biosecurity and health management

The respondents’ current health management primarily entails the treatment of diseases as they occur (a sore foot or a cough), rather than prevention of diseases (vaccination). The treatments are administered either by a veterinarian (three respondents), the farmer (two respondents) or both (one respondent) - one respondent did not use treatments. All of the respondents report that they have access to cold facilities (a refrigerator) for the storage of veterinary supplies.

Biosecurity concerns include the following:

- Access control: The farms do not have sufficient access control (fences, walls or barriers) along the perimeter of the facilities. This can lead to diseases being transferred between farms by animals or visitors.
- Disinfection: Two respondents report that they never disinfect their pens before the habitation of a new litter. This can lead to diseases being transferred from the litter previously inhabiting the pen to the next litter.
- Shared air spaces: Animals of different ages are reported to share the same air spaces. This can lead to disease transfer from older pigs to the younger pigs with a weaker immune system (Section 2.4.4).
- Sharing boars: Boars are shared between the farms for mating purposes. This can lead to the spread of diseases or inbreeding (if detailed production records are not kept).

4.1.5. Labour

Pig farming activities are performed by:

- The farmer and his family (three respondents).
- The farmer and support from neighbouring smallholder farmers (six respondents).
- The farmer and part-time labour (two respondents).
- Full-time labour (one respondent).

One of the respondents reported that a monthly salary of R 500 to R 1 000 (depending on the number of days worked) is paid per labourer.

4.1.6. Pig farming experience

The respondents' have been farming with pigs for one year (two respondents) to eleven years (one respondent) with herd sizes of five sows (two respondents) to 20 sow units (two respondents). The respondents have not had formal pig farming training. Piglets are weaned at the age of 21 to 28 days on commercial pig farms (Kyriazakis & Whittemore, 2006). However, the Empolweni respondents reported an average weaning age of 42 days. The late weaning age reduces the pig farm’s litters per sow per year potential. Delayed weaning is but one of a broad spectrum of suboptimal management practices that is the result of a lack of training.

4.2. Production performance gap analysis

4.2.1. Current case study community production performance

Table 4.2 provides the respondents' average production performance (according to the parameters discussed in Section 2.2.2), as well as input from the regional pig health experts (based on estimated production performance). The respondents do not keep detailed production performance records.

Table 4.2 The Empolweni community's estimated average pig production performance

Performance parameter	Pig health experts	Respondents
Litters per sow per year	<= 2	
Live born piglets per litter	9.5	
Pre-weaning mortality percentage	31.58% (3 piglet deaths for 9.5 live born piglets).	15.79% (1.5 piglet mortalities per 9.5 live born piglets)
Weaned pigs per litter	6.5	8
Post-weaning mortality percentage	23.08% (1.5 weaner / grower / finisher mortality per 6.5 weaned pigs per litter).	12.5% (1 weaner / grower / finisher mortality per 8 weaned pigs per litter).
Pigs sold/consumed per litter*	5	7
Pigs sold/consumed per sow per year*	<= 10	<= 14
Growth rate	Not available.	
Feed conversion ratio	Not available.	

***** Excludes the replacement of breeding stock from the herd.

Comments on Table 4.2:

- Litters per sow per year: Respondents and regional pig health experts stated that the average litters per sow per year are approximately two. However, this rate considers only individual sows and not the herd average in terms of litters per sow per year losses (sow mortalities, abortions or repeat services). Therefore, the litters per sow per year are less than or equal to two.
- Pre-weaning mortalities: Primarily because of sow crushing and hypothermia.
- Post-weaning mortalities: Primarily because of food poisoning and heat exhaustion.
- Growth rate: This performance parameter is not available because detailed production records are not kept. The growth rate of the smallholder farmers' pigs is considered to be significantly lower than that of the pigs raised by commercial farmers. Poor nutrition from swill feed is a potential reason for the poor growth rate.
- Feed conversion ratio (FCR): This performance parameter is not available because detailed production records are not kept.

4.2.2. Pig production performance gaps

Table 4.3 shows the production performance gaps between the Empolweni pig farmers (Section 4.2.1) and the average commercial piggeries production performance in the United Kingdom.

Table 4.3 Case study community pig production performance gaps

Performance parameter	Smallholder (Case study)		Large scale (Commercial)	Performance gap [1]
	Pig health experts	Respondents	United Kingdom [2, 3]	
Litters per sow per year	<= 2		2.34	>= 0.34
Live born piglets per litter	9.5		10.9	1.4
Pre-weaning mortality rate (%)	31.58	15.79	10.7	5.09 to 20.88
Weaned pigs per litter	6.5	8	9.73	1.73 to 3.23
Post-weaning mortality rate (%)	23.08	12.5	5.2	7.3 to 17.88
Pigs sold/consumed per litter	5	7	9.22	2.22 to 4.22
Pigs sold/consumed per sow per year	<= 10	<= 14	21.57	>= 7.57
Growth rate (days from birth to 100 kg live slaughter weight)	Not available.		<= 160	Not available.
Feed conversion ratio	Not available.		Weaner: 1.72. Grower: 1.69. Finisher: 3.26	Not available.

[1] The performance gap considers the difference between the average production performance of the commercial farms and the average case study production performance.

Source: [2] Kyriazakis & Whittemore, 2006 & [3] PIC, 2011

The performance gaps show that significant production performance improvements are required for the smallholder pig farmers to compete with commercial farms.

4.2.3. Gap analysis findings

The production performance gaps identified are the result of the following challenges:

- Inadequate housing and infrastructure: The current pig housing does not provide sufficient protection from weather conditions (Section 4.1.1).
- Security of tenure: The lack of security of tenure hinders organisations or the farmers from funding the construction of the facilities. Additionally, the farmers need to own or lease the land before electricity can be provided.
- Lack of vital equipment: Farrowing crates, creep areas and heating equipment (Section 4.1.1).
- Heating: None of the respondents have access to electricity. Consequently, none of the respondents have any form of heating.

The production performance gaps (continued):

- Pig production skills: None of the respondents have had formal pig production training (Section 4.1.6). Formal training is required to improve the respondent's current pig production performance level.
- Feed: Weaners, growers and finisher pigs experience malnutrition, diseases and suboptimal and non-uniform growth because of the use of swill feed (Section 4.1.2).
- Water: None of the respondents have direct access to a water supply (Section 4.1.3).
- Biosecurity: The respondents' use of swill feed and low biosecurity levels prevents them from having their pigs slaughtered at a registered abattoir (Section 4.1.4). Therefore, it is not possible for the Empolweni community's pig farmers to have access to a formal market for commercial pig farming. Additionally, the lack of biosecurity increases the possibility of diseases being introduced to the herd, which also prevents access to the formal market.
- Genetics: In contrast to the commercial pig farmers, the Empolweni pig farms do not have access to the best pig genetics in the world, through AI.

Most of the case study's challenges are comparable to national and global smallholder pig farming challenges (Section 2.4). The challenges identified will have to be negated (at least to a degree) for the smallholder pig farm design to have any chance of being economically feasible.

4.3. Design considerations

The "Design considerations" section considers the case study's challenges discussed in Section 2.4 and a potential means to reduce or negate them.

4.3.1. Housing, infrastructure and equipment

The primary reasons that prevent the Empolweni pig farmers from expanding their pig farming operations include a lack of the following:

- Abundant or affordable feed source: There is only a set amount of swill feed available and the farmers' are unable to afford the feed from the feed mills.
- Sufficient and easily accessible water sources: It is a time consuming activity to obtain water from the central water tank.
- Expertise: The maximum farm size is 20 sow units (Section 4.1.6). None of the respondents have any formal pig production training.
- Funds: None of the respondents received any funding from the government or other organisations.
- Land: Some of the farmers' lands are considered as fully utilised because of other farming activities and living space requirements.
- Reliable labour: Insufficient labourers are available to work at the rates that pig farmers can afford to pay.

The lack of experience and land limits the Empolweni pig farmers to a maximum of 20 sows per pig farm. The literature study entailed a discussion of the following estimates for the potential cost of adequate housing, infrastructure and equipment (Section 2.3.1):

- Casidra (Section 9.3): R 39 417 per sow (non-mechanised piggery).
- Commodico Distributors (Pty) Ltd. (2008): R 29 000 to R 35 000 per sow (mechanised piggery).
- Streicher (interview with Simon Streicher as discussed in Louw et al., 2011): R 25 000 (non-mechanised piggery) to R 40 000 (mechanised piggery) per sow.

Therefore, the cost of pig housing ranges from R 25 000 to R 40 000 per sow and the estimate amounts to R 500 000 to R 800 000 for a 20 sow pig farm. Security of tenure will have to be granted to the farmers before construction is possible.

4.3.2. Heating

The Empolweni pig farmers do not have access to an electricity supply. Two alternative energy sources (solar power and biogas) are discussed in Section 2.4.5. Solar power is considered as an infeasible heating power source because of the high installation costs (lowest estimate of R 58 986 per heating lamp (Table 9.1)), the high replacement costs after 5 to 9 years (Section 9.1) and the potential of irregular electricity supply during extended overcast weather conditions. Biogas is also considered as an infeasible heating fuel source because of its inconsistent production rate and the added dangers of its being a fire hazard. An electricity source must be able to consistently deliver (24 hours per day) the required amount of electricity to power the heating sources to ensure the highest levels of production performance.

Therefore, a direct electricity supply will be required to power the pig farm’s heating lamps. A direct electricity supply can be provided once security of tenure is ensured.

4.3.3. Pig production training

As discussed in Section 2.4.6, organisations, such as SAPPO, can provide training and expertise in support of the Empolweni smallholder pig farmers. Ideally, extension services should be provided for the community to ensure continuous pig production expertise support.

4.3.4. Feed

The swill feed needs to be replaced by balanced feed rations. As discussed in Section 2.3.3, Nova Feeds and Meadow Feeds can provide a nutritionally balanced feed source. Nova Feeds is judged as more feasible than Meadow Feeds because its feed costs is less expensive and the Nova Feeds feed mill is located closer to Mamre than Meadow Feeds’ mill.

4.3.5. Water

A farrow-to-finish piggery requires approximately 78 litres of water per sow per day (Section 2.3.3). Therefore, a 20 sow pig farm requires approximately 1560 litres of water per day. The case study pig farmers require a direct water supply to ensure the availability of fresh water for the herd.

4.3.6. Biosecurity

The biosecurity requirements for commercial pig farming, as discussed in Section 2.4.7, are adhered to through the improved pig housing, a balanced diet and improved training. A vaccination programme, outlined in Section 2.3.3, needs to be introduced.

4.3.7. Genetics

Artificial insemination (AI) needs to replace the current natural mating system of the Empolweni pig farmers to make the following benefits possible (Section 2.3.3):

- Improved production performance through improved genetics.
- Fewer on-site boars required.
- Lower quality boars required (boars are only used for stimulation and heat detection).
- Eliminates the possibility of inbreeding and sexually transmitted diseases.

PIC South Africa recommends the Camborough 22 (C22) (25% Large White, 25% Landrace, 50% White Duroc) commercial crossbreed female for smallholder pig farmers in the Western Cape (Personal communication, A. De Villiers, PIC South Africa Technical Adviser (Kanhym Estates), 3 November 2011). The Empolweni pig farmers can obtain the AI dosages from agents in Bellville and Malmesbury. Western Cape PIC technicians can support smallholder pig farmers with AI training (Personal communication, A. De Villiers, PIC South Africa Technical Adviser (Kanhym Estates), 3 November 2011).

The terminal cross breeding system necessitates the replacement of breeding stock from outside the herd.

4.4. Base commercial smallholder pig farm model

The base commercial smallholder pig farm model (henceforth referred to as the base model) refers to the average projected production and financial performance of the commercial smallholder pig farm improvement endeavour.

4.4.1. Production plan

The proposed base smallholder commercial pig farm entails a 20 sow pig farm with one boar for breeding stimulation. Table 4.4 shows the estimated production performance (based on the production performance as discussed in Section 2.2.2) and the maximum pig production potential (based on the C22's production performance potential).

Table 4.4 Base model and maximum potential production performance

Production parameter	Base model potential	Maximum potential [6]
Litters per sow per year	2.3 [1]	> 2.39
Live born piglets per litter	10 [2]	> 11.5
Pre-weaning mortalities (%)	11 [2]	< 9
Weaning age	28	21 to 28
Weaners per litter	8.90	> 10.47
Post-weaning mortalities (%)	5.5 [2]	< 4.5
Slaughter pigs per litter	8.41	> 10
Slaughter pigs per sow per year	19.34	> 23.86
Days to 100 kg live weight	168 [3]	154
FCR (Average weaner to slaughter)	2.69 [4]	2.36 [5]

[1] The average South African litters per sow per year (Section 2.2.2).

[2] Less than the United Kingdom average production performance level but within an acceptable range (Kyriazakis & Whittemore, 2006).

[3] Growth rate as discussed in the pig production cycle example (Section 2.2.1 & 2.2.2).

[4] Less than the good FCR level (Section 2.2.2).

[5] Less than the target FCR level (Section 2.2.2).

Source: [6] PIC, 2002; Kyriazakis & Whittemore, 2006

Batch farrowing system

The three week all-in-all-out batch farrowing system is proposed for the smallholder commercial pig farm. This involves dividing the 20 sows into seven farrowing groups of three sows each (except for the last group that will have two sows). The seven farrowing groups' production cycle will be three weeks apart. Therefore, when group seven completes its production cycle, group one's production cycle will start three weeks later. This allows the farmer to focus on one important function (farrow, wean or service) per week (Kyriazakis & Whittemore, 2006; Aland & Madec, 2009).

Refer to Figure 9.1 for a graphical representation of the 20 sow three week batch farrowing system.

Breeding stock replacements

The sow's estimated lifetime is six to seven litters (PIC, 2002). Therefore, the base commercial model will use an average lifetime of three years for the sow (total of seven litters / 2.3 litters per sow per year) and the boar. A third of the breeding stock is replaced per year to compensate for poor sow performance, mortalities and the breeding stock lifespan.

Therefore, a total of seven breeding stock pigs ([20 sows + one boar] / three year lifetime) needs to be replaced per year. The boar is replaced from the herd's grower population and the sows are replaced by pregnant C22 sows from outside the herd.

Pigs produced per year

An average of 19.343 slaughter pigs with a live weight of 100 kg is produced per sow per year. Therefore, the 20 sow herd will produce 386.53 (19.343 x 20 sows – 1/3 replacement boar (one boar / three year lifetime).

4.4.2. Start-up costs

Land

The land will require an environmental impact study before construction can commence. If construction is approved and the local government is willing to grant the land to the community, the current land can be used for the construction of the facilities. No costs will be associated with the acquisition of land for the base commercial model.

Housing, infrastructure and equipment

The housing, infrastructure and equipment are estimated to have a minimum cost of R 500 000 and a maximum cost of R 800 000 (Section 4.3.1). The average cost of R 650 000 ([R 500 000 + R800 000] / 2) will be used as the average cost for the housing, infrastructure and equipment of a 20 sow pig farm. The average cost is chosen because of the low level of mechanisation of the proposed facility (decreased cost per sow) and the higher housing costs per sow for smaller piggeries (increased cost per sow). Therefore, the 20 sow piggery's housing, infrastructure and equipment costs (per sow) amounts to R 32 500 (R 650 000 / 20 sows).

Initial breeding stock

The initial breeding stock costs are discussed in Section 2.3.1. The costs include:

Pregnant sows' costs
= Sows (#) x Cost per sow (R)
= 20 x R 4 000
= R 80 000

Stimulation boar's costs
= Boars (#) x Cost per boar (R)
= 1 x R 3 500
= R 3 500

Initial breeding stock costs
= Pregnant sows' costs + Stimulation boar's costs
= R 80 000 + R 3 500
= R 83 500

First year production costs

This cost will be calculated in Section 4.4.4.

4.4.3. Estimated annual income

A view of potential Western Cape markets' is portrayed by the following two Western Cape abattoirs:

- Winelands Pork abattoir in Bellville, Western Cape (Personal communication, H. Bosch, Winelands Pork Financial manager, 31 October 2011).
- Roelcor abattoir in Malmesbury, Western Cape (Personal communication, L. Bothma, Roelcor Abattoir manager (Malmesbury), 04 November 2011).

For the purposes of the model, the assumption is that the Roelcor abattoir will always have sufficient capacity for slaughter pigs.

Slaughter pigs income

A 100 kg live weight slaughter pig has an estimated dressing percentage of 77.13% (estimated dressing percentage of a 102 kg live weight pig as shown in Table 2.2). Therefore, the carcass weight will amount to 77.13 kg (100 kg x 77.13%). The average pork price received per kg carcass weight (July 2011 to June 2012) for a baconer is R 18.00 (Section 2.3.2).

Estimated annual income from slaughter pigs (calculation from Section 2.3.2)

= Slaughter pigs (#) x Carcass weight (kg) x Pork price (R/kg)

= 386.53 slaughter pigs x 77.13 kg x R 18.00

= R 536 635

Culled pigs income

The production plan is based on the assumption that seven breeding stock pigs are culled per year. However, only the sows can be sold. Therefore, only 6.67 pigs (20 sows / 3 years) are culled and sold per year. The culled sows are sold as sausage pigs. The average sausage pig pork price was R 12.01 per kg (average carcass weight of 152.60 kg) from July 2011 to June 2012 (Red Meat Industry Forum, 2012).

Estimated annual income from culled pigs (calculation from Section 2.3.2)

= Culled pigs (#) x Carcass weight (kg) x Price received (R/kg)

= 6.67 culled pigs x 152.60 kg x R 12.01

= R 12 224

Total annual income

= Slaughter pigs income + Culled pigs income

= R 536 635 + R 12 829

= R 548 859

4.4.4. Estimated annual production costs

Feed costs

The annual feed costs of the base model are based on Nova Feeds' prices and recommended daily feed amounts. The feed costs (including delivery) per slaughter pig amount to R 840.65 (Section 2.3.3). Therefore, the feed costs of 386.86 marketable pigs' (100 kg live weight) amount to R 325 214 (386.86 slaughter pigs x R 840.65).

If the post-weaning mortalities occur at the end of the weaner production stage, then the feed costs of a total of 22.52 weaners' (20 sows x 8.90 weaners per litter x 2.3 litters per sow per year x 5.5% post-weaning mortalities) would have to be considered. The cost per post-weaning mortality weaner amounts to R 189.65 (R 5.54 + R 59.31 + R 124.80 (Table 2.6)). Therefore, the total cost for post-weaning weaner mortalities would amount to R 4 271 (R 189.65 x 22.52).

The replacement boar is replaced by one of the marketable pigs and the replacement breeding stock sows are replaced with pregnant C22 sows. The replacement boar is required to reach an age of 10 months (300 days) before it can be effectively used for the stimulation of production sows (PIC, 2002). An additional 132 days after slaughter age (168 days), is required to grow the boar to the required age. The replacement boar has daily feed requirements of 2.3 kg per pig per day (Personal communication, S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011). The average cost of boar feed is R 3.15 per kg ([R 3 060 + R 3 240] / 2 / 1 000) (Table 2.5).

Replacement boars' annual feed cost

= [Boars (#) / replacement rate (years)] x Feeding time (days) x Daily feed required (kg) x Feed cost (R/kg)

= [1 boar / 3 years] x 132 days x 2.3 kg x R 3.15

= R 319

The stimulation boar and the dry sows require 2.3 kg of feed per day at R 3.15 per kg. A sow requires 2.3 kg of lactation feed (R 3.51 per kg) for the seven days prior to farrowing. After farrowing, the lactating sow will require 7 kg of lactation feed per day until weaning (Personal communication, S. Wolhuter, Nova Feeds technical advisor (Malmesbury), 11 November 2011).

Boars' annual feed cost

= Boars (#) x Feeding time (days) x Daily feed required (kg) x Feed cost (R/kg)

= 1 boar x 365 days x 2.3 kg x R 3.15

= R 2 644

Dry sows' annual feed cost

= Sows (#) x Feeding time (days) x Daily feed required (kg) x Feed cost (R/kg)

= 20 sows x (365 annual days – 82 lactation feed days) x 2.3 kg x R 3.15

= R 41 007

Lactating sows' annual feed cost (partial days are rounded up)

= Pre-farrowing lactation feed cost + Post-farrowing lactation feed cost

= (Sows (#) x Litters per sow per year (#) x Feeding time (days) x Daily feed required (kg) x Feed cost (R/kg))$_{\text{Pre-farrowing}}$ + (Sows (#) x Litters per sow per year (#) x Feeding time (days) x Daily feed required (kg) x Feed cost (R/kg))$_{\text{Post-farrowing}}$

= (20 sows x 2.3 litters per sow per year x 7 days x 2.3 kg x R 3.51)$_{\text{Pre-farrowing}}$ + (20 sows x 2.3 litters per sow per year x 28 days x 7 kg x R 3.51)$_{\text{Post-farrowing}}$

= R 2 745 + R 31 941

= R 34 686

A 4% feed compensation is required for feed waste losses (Personal communication, H. Cronje, Owner of Sweetwell Farm & Butchery, 14 June 2010). Additionally, the total feed costs are reduced by 4% to convert the current feed costs to the average annual feed costs (Section 2.3.3).

Total annual feed costs
= (Slaughter pigs' feed cost + Post-weaning losses' feed cost +
Replacement boar's feed cost + Boar's feed cost + Dry sows' feed cost +
Lactating sows' feed cost) x (100% + Feed wastage compensation percentage) x
(100% - Average annual conversion percentage)
= (R 325 214 + R 4 271 + R 319 + R 2 644 + R 41 007 + R 34 686) x
104% feed wastage compensation x 96% average annual conversion
= R 407 488

The FCR level (weaner to slaughter) amounts to 2.69 ((237.5 kg feed x (100% + 4% feed wastage compensation)) / 91.75 kg live weight gain).

Veterinary supplies costs

Veterinary supplies costs are discussed in Section 2.3.3. Vaccines have to be discarded after opening.

The vaccination costs for sows:

- Farrowsure+B (Parvo/Lepto/Erysipelas): R 763.75 (50 dosages) per farrowing group per litter.
- Scourmune C (E-Coli + Clostridium): R 634.50 (50 dosages) per farrowing group per litter.

Sows' annual vaccination costs
= (Farrowsure container cost + Scourmune container cost) x Farrowing groups x
Litters per sow per year
= (R 763.75 + R 634.50) x 7 farrowing groups x 2.3 litters per sow per year
= R 22 512

The vaccination and injection costs for piglets

- M+Pac (Mycoplasma): R 111.63 (100 dosages) – 2 dosages per piglet. Therefore, 2 containers are required per farrowing group per litter.
- Ferdex 20% (iron injection): R 176.25 (25 dosages) – One iron injection per piglet. Iron injection containers do not require discarding after use. Therefore, the cost per injection amounts to R 7.05 (R 176.25 / 25 injections).

Piglets' annual vaccination and injection costs
= M+Pac container cost x Containers x Farrowing groups x Litters per sow per year +
Sows x Live born piglets per litter x Litters per sow per year x
Ferdex container cost / injections
= R 111.63 x 2 containers x 7 farrowing groups x 2.3 farrowings per year + 10 piglets x 2.3 litters per sow per year x 20 sows x R 176.25 / 25 injections
= R 6 837

Veterinary supplies are expensive because of the discarding requirement. Larger scale pig farms are able to utilise their veterinary supplies more efficiently as a result of fewer dosages being discarded. If the vaccinations are optimally administered (no discarding), the cost amounts to R 5 557 (refer to the following calculations). The optimal cost excludes the cost of additional veterinary supplies.

Farrowsure optimal costs
= Farrowsure container cost x Farrowing groups x Litters per sow per year
= (R 763.75 / 50 dosages) x 20 sows x 2.3 farrowings per year
= R 703

Scourmune optimal costs
= Scourmune container cost x Farrowing groups x Litters per sow per year
= (R 634.50 / 50 dosages) x 20 sows x 2.3 farrowings per year
= R 584

M+Pac optimal costs
= Sows x Live born piglets per litter x Farrowings per year x
M+Pac container cost / dosages x Dosages per farrowing
= (R 111.63 / 100 dosages) x 20 sows x 10 piglets x 2.3 farrowings per year x 2 dosages
= R 1 027

Ferdex 20% optimal costs
= Sows x Live born piglets per litter x Farrowings per year x Ferdex container cost / injections
= (R 176.25 / 25 injections) x 20 sows x 10 piglets x 2.3 farrowings per year
= R 3 243

Optimal utilisation of veterinary supplies cost
= Farrowsure optimal costs + Scourmune optimal costs + M+Pac optimal costs +
Ferdex 20% optimal costs
= R 703 + R 584 + R 1 027 + R 3 243
= R 5 557

The costs above only consider the veterinary supplies required for vaccination and the iron injection. Additional veterinary supplies will be required if diseases or parasites (such as mange) should affect the herd. A conservative additional cost of R 50 per sow will be added to the veterinary supplies costs to compensate for potential additional veterinary supplies requirements. Veterinary call-outs and consultation will have to be provided by extension services free of charge to the smallholder farmers (Personal communication, Q. Nyoka, SAPPO's Portfolio Committee for Emerging Farmers, 6 August 2010).

Total annual veterinary supplies costs
= Sows' annual vaccination costs + Piglets' annual vaccination and injection costs + Additional veterinary supplies
= R 22 512 + R 6 837 + R 1 000
= R 30 349

Replacement sows costs

As discussed in Section 2.3.1, the cost per pregnant C22 sow is R 4 000. As discussed in Section 4.4.1, an average of 6.67 sows (20 sows / three years lifespan) will be replaced per year. Therefore, the replacement sows costs amount to R 26 680 per year (R 4 000 x 6.67 sows).

Artificial insemination costs

Artificial insemination (AI) costs amount to R 113.20 per farrowing (Section 2.3.3).

Artificial insemination costs
= Sows (#) x Litters per sow per year x AI costs per farrowing
= 20 sows x 2.3 litters per sow per year x R 113.20
= R 5 207

Transport costs

The transport cost per km is discussed in Section 2.3.3. Transport is required for the transportation of slaughter and culled pigs to the abattoir, to purchase AI dosages, veterinary and other supplies, **to** transport feed from the feed mill to the farm and to transporting replacement sows from Malmesbury to the farm. The Roelcor abattoir (Malmesbury) is the base model's chosen market (Section 4.4.3). The culled pigs are transported with the slaughter pigs as required.

Abattoir transport total vehicle operating cost

= [Fixed cost (R/km) x 60 km + Running cost (fully loaded & trailer adjustment) x 30 km + Running cost (trailer adjustment) x 30 km] x Sows (#) x Litters per sow per year

= [R 1.57 x 60 + R 1.54 x 1.20 x 30 + R 1.54 x 1.08 x 30] x 20 sows x 2.3 litters per sow per year

= [R 94.20 + R 55.44 + R 49.90] x 46 litters

= R 9 179

The AI dosages, replacement sows and the veterinary and other supplies are collected at Malmesbury when the farmer transports the slaughter pigs to the abattoir. Therefore, no extra transport cost is required to obtain the AI dosages, replacement sows and the veterinary and other supplies. Feed delivery costs are included in feed costs (Section 2.3.3).

The transport costs amount to R 9 179 per year.

Living costs

The proposed commercial farm's pig producer needs to devote all his attention to the farm and will be unable to have another day job. Therefore, the pig farm will have to provide sufficient income for the farmer's household expenses. A monthly income of R 3 138 (LSM 4) is judged as sufficient for the farmer and his household's livings expenses (South African Advertising Research Foundation, 2012). A total of R 37 656 (R 3 138 x 12 months) is required for living costs per year.

Labour costs

Section 4.1.5 shows that a minority of the respondents hire labourers to support their pig farming activities. The majority of the commercial pig farm labour will be performed by the pig farmer and his household. However, as stated in Section 2.3.3, at least part-time labour is required to provide support. One labourer, working one week per month, is deemed as sufficient support for a 20 sow pig farm. As stated in Section 2.3.3, the minimum farmworker wages per week is R 318. Therefore, the annual labour costs will amount to R 3 816 (R 318 x 12 months) or R 190.80 per sow (R 3 816 / 20 sows).

Utility costs

The electricity costs are determined primarily by the cost of heating. As discussed in Section 2.3.3, the heating lamps are 90% efficient, 0.175 kW and cost 0.52 R/kWh. Heating is required 24 hours per day for 35 days per litter (Section 2.2.1).

Electricity costs per year

= [Heating lamp wattage (kW) x Daily heating hours (h) x Heating period (days) x Electricity cost (R/kW) / Efficiency (%)] x Sows (#) x Litters per sow per year

= [0.175 kW x 24 hours x 45 days x R 0.52 / 0.90] x 20 sows x 2.3 litters per sow per year

= R 5 023

A farrow-to-finish piggery requires approximately 78 litres of water per sow per day (Section 2.3.3). Therefore, a 20 sow pig farm requires approximately 1.56 kL of water per day or 569.4 kL per year (1.56 kL x 365 days). An average of 47.45 kL (569.4 kL / 12 months) is required per month. The water cost calculation method is discussed in Section 2.3.3.

Annual fresh water cost

= [6 kL x R 0.00 + (10.5 - 6) kL x R 4.92 + (20 - 10.5) kL x R 10.51 + (35 - 20) kL x R 15.57 + (47.45 - 35) kL x R 18.99] x 12 months

= [R 22.14 + R 99.85 + R 233.55 + R 236.43] x 12

= R 7 104

The sanitation will be charged at a monthly consumption level of 33.22 kL (70% x 47.45 kL).

Annual sanitation cost

= [4.2 kL x R 0.00 + (7.35 – 4.2) kL x R 5.05 + (14 – 7.35) kL x R 10.76 + (24.5 - 14) kL x R 11.77 + (33.22 – 24.5) kL x R 12.36] x 12 months

= [R 15.91 + R 71.55 + R 123.59 + R 107.78] x 12

= R 3 826

Total annual water cost

= Annual fresh water cost + Annual sanitation cost

= R 7 103 + R 3 826

= R 10 929

This study does not compensate for the potential use of boreholes or dams to reduce the cost of water resources.

Total annual utility costs

= Electricity costs + Water costs

= R 5 023 + R 10 929

= R 15 952

Maintenance, repairs and replacements

As discussed in Section 2.3.3, maintenance and repairs budgeting is highly dependent on the location, construction materials and the level of mechanisation/automation of the farm. The base model only requires simple construction materials and no mechanisation. Therefore, a relatively low cost will be required for maintenance budgeting.

An amount of R 12 000 per year (R 1 000 per month or R 600 per sow per year) is judged as sufficient for maintenance costing (Personal communication, H. Cronje, Owner of Sweetwell Farm & Butchery, 14 June 2010).

Equipment replacements entail primarily the replacement of heating lamps. The Technilamp 175 Watts heating lamp has a lifetime of 5 000 hours (Personal communication, Schreck, W., Technilamp, 18 April 2012).

Heating lamps required per year
= Sows (#) x Litters per sow per year x Daily heating hours (h) x Heating period (days) / Lifetime (h)
= 20 sow x 2.3 litters per sow per year x 24 hours x 45 days / 5 000 hours
= 9.936
~ 10 heating lamps

The heating lamp replacement costs (including brackets) amount to R 211 (including VAT) per lamp (Personal communication, Schreck, W., Technilamp, 18 April 2012). Therefore, the annual heating lamp replacement costs amount to R 2 110 (R 211 x 10 heating lamps). The total annual maintenance, repairs and replacements costs amount to R 14 110 (R 12 000 + R 2 110).

Diverse costs

Additional costs include the cost of disinfection supplies, bedding, office supplies, telephone charges and the chemicals for pest control. The cost for these items is relatively low and amounts to R 6 000 per year (R 500 per month), which is considered as sufficient for a 20 sow piggery (Commodico Distributors (Pty) Ltd., 2008; Personal communication, H. Cronje, Owner and manager of Sweetwell Farm & Butchery, 14 June 2010). Therefore, diverse costs amount to R 300 per sow per year (R 6 000 / 20 sows).

4.4.5. Base model overview

The start-up costs and the first year's production costs are assumed to be funded by the government or another organisation. The proposed model was validated by Mr John Morris (Personal communication, J. Morris, manager of the Mariendahl Experimental farm (Stellenbosch), 23 June 2011) and Mr Nico de Kock (Personal communication, N. de Kock, Department of Agriculture Agricultural Economist - Farmer Support & Development: West Coast (Malmesbury), 1 August 2011). Table 4.5 shows a summary of Section 4.4.

Table 4.5 Base model's financial information

	Estimated cost	% of total
Start-up costs	R 1 289 937	**% of Start-up costs**
Housing, infrastructure & equipment	R 650 000	50.39%
Breeding stock	R 83 500	6.47%
First year production costs	R 556 437	43.14%
Annual income	R 548 859	**% of Annual income**
Slaughter pigs income	R 536 635	97.77%
Culled pigs income	R 12 224	2.23%
Annual production costs	R 556 437	**% of Annual production costs**
Feed costs	R 407 488	73.23%
Living costs	R 37 656	6.77%
Veterinary supplies	R 30 349	5.45%
Replacement sows costs	R 26 680	4.79%
Utilities	R 15 952	2.87%
Maintenance, repairs & replacements	R 14 110	2.54%
Transport costs	R 9 179	1.65%
Diverse costs	R 6 000	1.08%
Artificial insemination costs	R 5 207	0.94%
Labour costs	R 3 816	0.69%
Annual profit/loss	-R 7 578	
Annual return on investment (ROI)	-1.36%	

ROI calculation

= (Annual profit [or loss] / Annual production costs) %

The base model has a potential annual loss of R 7 578 and an ROI of -1.36%. In Section 2.3.4, Streicher (interview with Simon Streicher as discussed in Louw et al., 2011) states that a sub-10% ROI is a risk-prone pig farm because of the potential of profits being insufficient to compensate for the annual cost inflation or a reduction in income as a result of reduced pork prices or a lower production performance. Therefore, for a commercial pig farm to be economically feasible, a profit of at least 10% of the annual production costs is required.

5. Evaluation

The evaluation chapter investigates the influence of adjustments to several vital parameters affecting the profitability and sustainability of four production performance scenarios. Pig farm sustainability is achieved for a ROI of 10% or more (Section 2.3.4).

5.1. Production performance scenarios

Four production performance scenarios are used to enable the sensitivity analysis. The four scenarios are the following:

- Scenario 1: The Empolweni community's current production performance level as reported by the respondents (Table 4.2). The growth rate and FCR level is set at a lower level than the base model's performance levels.
- Scenario 2: The base model (Table 4.4).
- Scenario 3: This scenario is based on an adaption of the United Kingdom's average production performance level (Table 4.3).
- Scenario 4: This scenario is a modified version of the Camborough 22 commercial crossbreed female's minimum production performance level under ideal conditions (Table 4.4).

The scenarios' calculations are provided in Section 9.5. Table 5.1 provides each scenario's production performance parameters and Table 5.2 provides the resulting financial information.

Table 5.1 Production performance scenarios' parameters

Scenario	1	2	3	4
Litters per sow per year	2.00	2.30	2.34	2.39
Live born piglets per litter	9.50	10.00	10.90	11.50
Pre-weaning mortalities (%)	15.79	11.00	10.70	9.00
Weaning age	28	28	28	28
Weaners per litter	8.00	8.90	9.73	10.47
Post-weaning mortalities (%)	15.00	5.50	5.20	4.50
Slaughter pigs per litter	6.80	8.41	9.23	10.00
Slaughter pigs per sow per year	13.60	19.34	21.59	23.89
Growth rate - 100 kg live weight (Days)	180	168	160	154
FCR - Birth to slaughter	2.76	2.69	2.46	2.33

Source: PIC, 2002; Kyriazakis & Whittemore, 2006; PIC, 2011

Table 5.2 Production performance scenarios' financial information

Scenario	1	2	3	4
Start-up costs	**R 1 201 454**	**R 1 289 937**	**R 1 307 872**	**R 1 325 866**
Housing, infrastructure & equipment	R 650 000	R 650 000	R 650 000	R 650 000
Breeding stock	R 83 500	R 83 500	R 83 500	R 83 500
First year production costs	R 467 954	R 556 437	R 574 372	R 592 366
Annual income	**R 389 390**	**R 548 859**	**R 611 474**	**R 674 724**
Slaughter pigs income	R 377 166	R 536 635	R 599 250	R 662 500
Culled pigs income	R 12 224	R 12 224	R 12 224	R 12 224
Annual production costs	**R 467 954**	**R 556 437**	**R 574 372**	**R 592 366**
Feed costs	R 325 792	R 407 488	R 424 249	R 440 933
Living costs	R 37 656	R 37 656	R 37 656	R 37 656
Veterinary supplies	R 26 380	R 30 349	R 31 163	R 32 005
Replacement sows costs	R 26 680	R 26 680	R 26 680	R 26 680
Utilities	R 15 297	R 15 952	R 16 039	R 16 148
Maintenance, repairs & replacements	R 13 823	R 14 110	R 14 133	R 14 179
Transport costs	R 7 981	R 9 179	R 9 338	R 9 538
Diverse costs	R 6 000	R 6 000	R 6 000	R 6 000
Artificial insemination costs	R 4 528	R 5 207	R 5 298	R 5 411
Labour costs	R 3 816	R 3 816	R 3 816	R 3 816
Annual profit/loss	-R 78 564	-R 7 578	R 37 102	R 82 359
Annual ROI	-16.79%	-1.36%	6.46%	13.90%

Production performance scenarios' preliminary economic feasibility:

- Scenario 1: Neither profitable nor sustainable.
- Scenario 2: Neither profitable nor sustainable.
- Scenario 3: Profitable but not sustainable.
- Scenario 4: Profitable and sustainable.

5.2. Sensitivity analysis

The sensitivity analysis evaluates the following parameters.

Pork prices

The income (Section 4.4.3) is subject to the number of slaughter pigs (determined by the production performance level), the carcass weight and the pork price (which is determined by the abattoirs and the pork quality). In terms of income, the pork price is the parameter that the pig farmer has the least control over.

Feed costs

Feed costs amount to more than 70% of the total production costs for each of the four scenarios. This cost is the highest contributor to production costs (Table 4.5).

Living costs

Living costs amount to more than 6% of the total production costs for the four scenarios. This cost is the second highest contributor to production costs (Table 4.5).

Interest on loans

This section explores the possibility of the farmer funding his own pig farm (full or partial funding).

Unit size

The unit size sensitivity analysis explores how the economic feasibility changes as the size of the pig farm increases.

Growth rate

As discussed in Section 2.2.2, pig genetics improvements over the years have substantially enhanced the pig growth rate. This sensitivity analysis will evaluate the influence of improved growth rates on the four scenarios' ROI.

Live weight at slaughter

This sensitivity analysis considers the influence of alternative live weights at slaughter for the four scenarios.

5.2.1. Pork prices

The price received per kg carcass weight (the pork price) depends on various factors such as seasonality, the carcass classification and the prices offered by formal markets / abattoirs. Figure 5.1 shows how the scenarios' profit / loss are affected by adjustments to the average annual pork price (R 18) as discussed in Section 2.3.2.

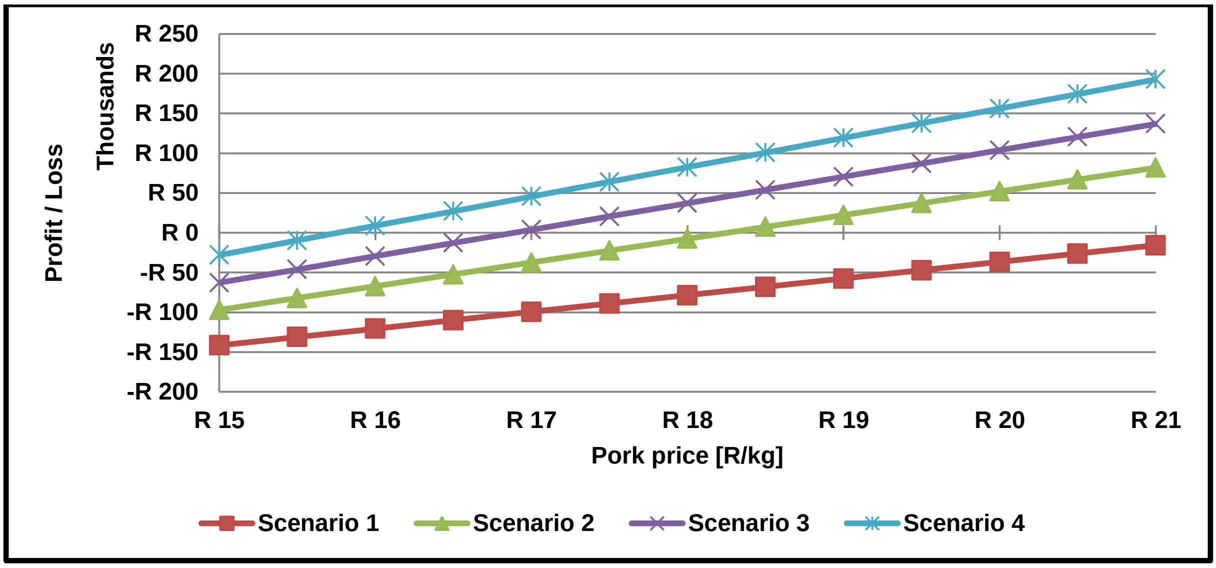


Figure 5.1 **The effect of pork price adjustments on the scenarios' profit / loss**

Break-even pork prices (Figure 5.1):

- Scenario 1: R 21.75 per kg (20.83% adjustment to the base pork price).
- Scenario 2: R 18.25 per kg (1.41% adjustment to the base pork price).
- Scenario 3: R 16.89 per kg (-6.19% adjustment to the base pork price).
- Scenario 4: R 15.76 per kg (-12.43% adjustment to the base pork price).

Figure 5.2 shows how the scenarios' ROI is affected by adjustments to the base pork price.

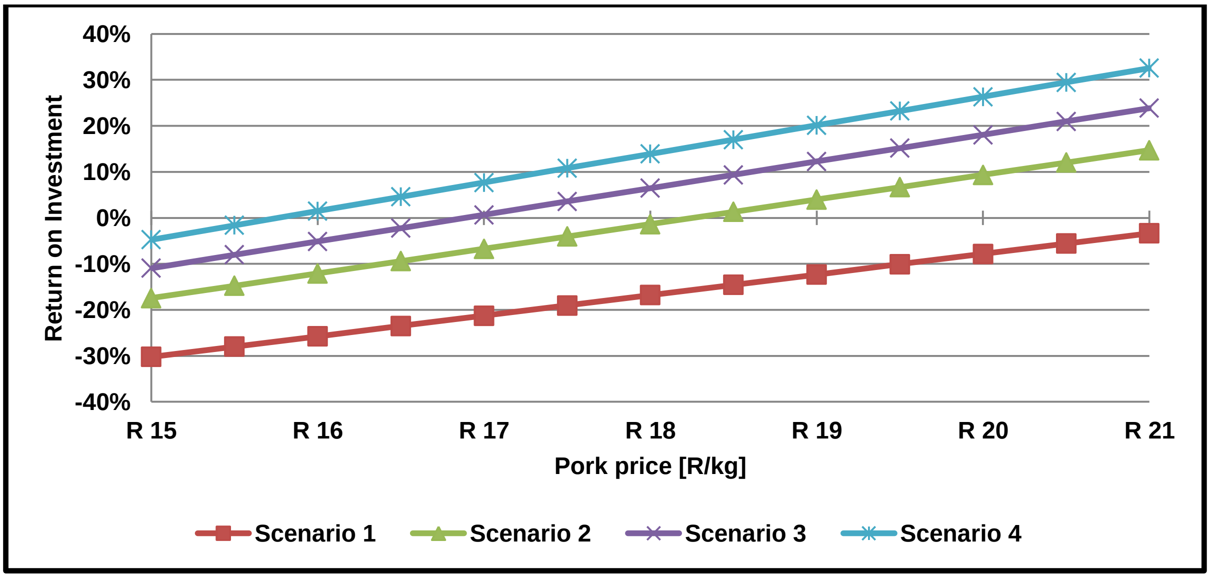


Figure 5.2 **The effect of pork price adjustments on the scenarios' ROI**

Pork price at 10% ROI (Figure 5.2):

- Scenario 1: R 23.98 per kg (33.24% adjustment to the base pork price).
- Scenario 2: R 20.12 per kg (11.78% adjustment to the base pork price).
- Scenario 3: R 18.61 per kg (3.39% adjustment to the base pork price).
- Scenario 4: R 17.37 per kg (-3.49% adjustment to the base pork price).

Figure 5.3 shows the South African average annual pork prices from 2003 to 2012. The annual averages are calculated from July to June the following year (e.g. the 2012 average pork price is calculated as the average pork price from July 2011 to June 2012). This figure provides a perspective on potential future pork price changes.

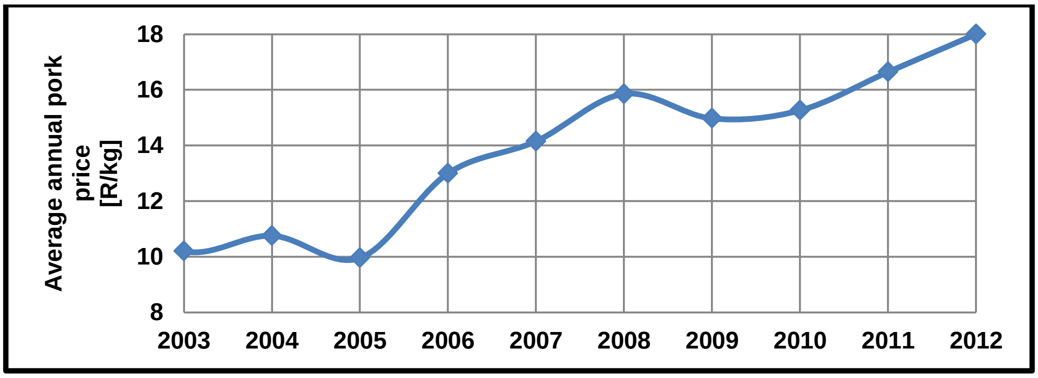


Figure 5.3 South African historic average annual pork prices

Source: Directorate Agricultural Statistics, 2012; First National Bank, 2012

The average year-on-year pork price increases by 4.67% for the past 10 years (2003 to 2012). However, the average year-on-year pork price percentage change for the past 5 years (2008 to 2012) is 5.13% and 6.38% for the past 3 years (2010 to 2012). Between 2003 and 2012, the maximum year-on-year change was an increase of 30.55% (2005 to 2006) and the minimum year-on-year change was a decrease of 7.44% (2004 to 2005).

The trend shows that Scenario 1 will not be able to achieve profitability (a pork price increase of 20.83% is required). Scenario 2 can potentially achieve profitability because a pork price increase of 1.41% is required. Neither Scenarios 1 nor 2 are likely to achieve a ROI of 10% or more. Therefore, neither of the two scenarios can potentially achieve sustainability through pork price changes.

Scenario 3 requires a pork price increase of 3.39% to achieve sustainability. The pork price trend over 5 years supports this pork price increase requirement. Scenario 4 does not require any pork price changes to achieve sustainability.

5.2.2. Feed costs

Feed costs are the highest production cost and amount to 73% of the total annual production costs of the base model (Scenario 2). Feed costs are highly dependent on yellow maize prices (Section 2.3.3) and if a high increase in maize prices should occur, feed costs will increase by a significant margin. Therefore, the historic South African yellow maize prices could indicate the potential future year-on-year percentage feed costs changes.

Figure 5.4 shows the yellow maize gross producer prices (averaged annually from July to June) from 2003 to 2012.

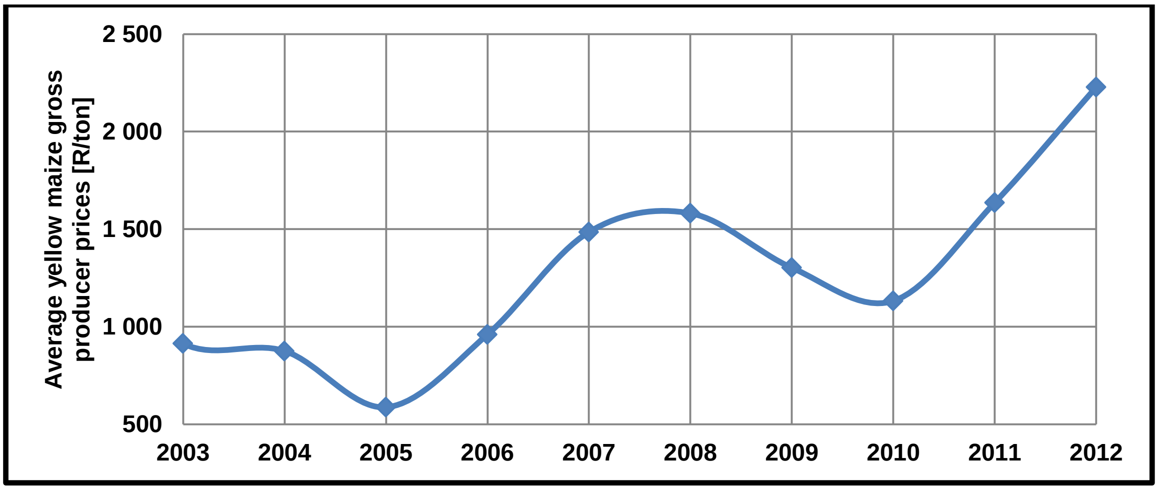


Figure 5.4 South African historic average yellow maize gross producer prices

Source: Directorate Agricultural Statistics, 2012; First National Bank, 2012

The average year-on-year change (2003 to 2012) of feed costs is an increase of 10.42%. However, the year-on-year price changes for the past 5 years (2008 to 2012) amounts to an increase of 11.29% and for the past 3 years (2010 to 2012) amounts to an increase of 22.52%. The extreme volatility of feed costs is best portrayed by the maximum and minimum year-on-year changes from 2003 to 2012. The maximum year-on-year increase was 63.54% (2005 to 2006) and the minimum year-on-year change was a decrease of 32.91% (2004 to 2005).

Figure 5.5 shows how the scenarios’ profit / loss are affected by adjustments to the base feed prices (Section 2.3.3).

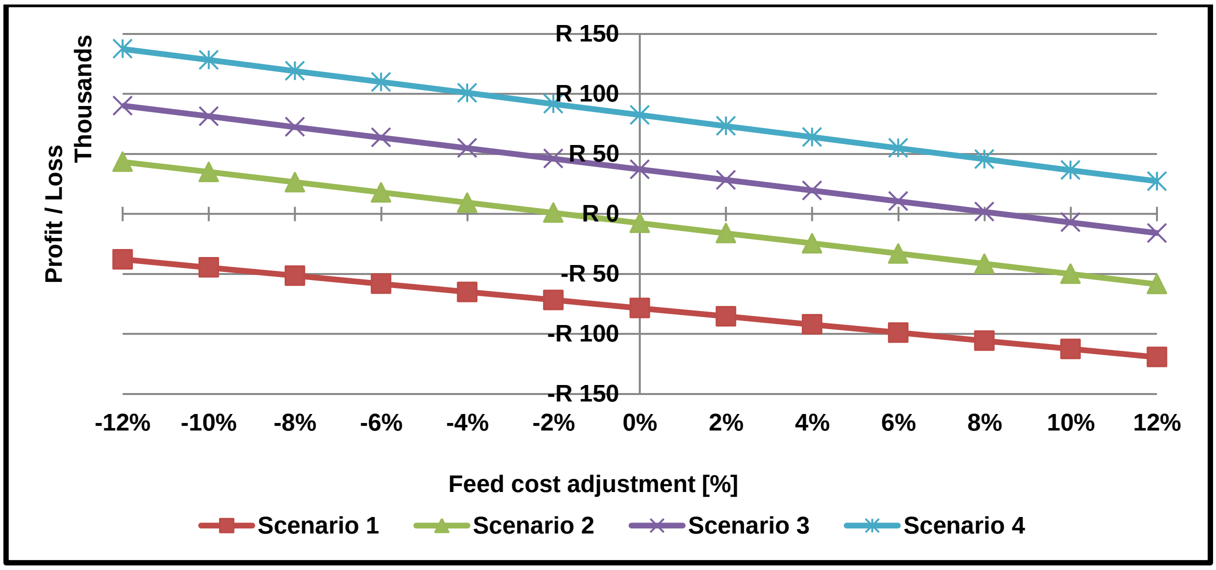


Figure 5.5 The effect of feed cost adjustments on the scenarios' profit / loss

Break-even feed costs (Figure 5.5):

- Scenario 1: -23.15% adjustment to the base feed costs.
- Scenario 2: -1.79% adjustment to the base feed costs.
- Scenario 3: 8.40% adjustment to the base feed costs.
- Scenario 4: 17.93% adjustment to the base feed costs.

Figure 5.6 shows how the scenarios' ROI is affected by adjustments to the base feed costs (Section 2.3.3).

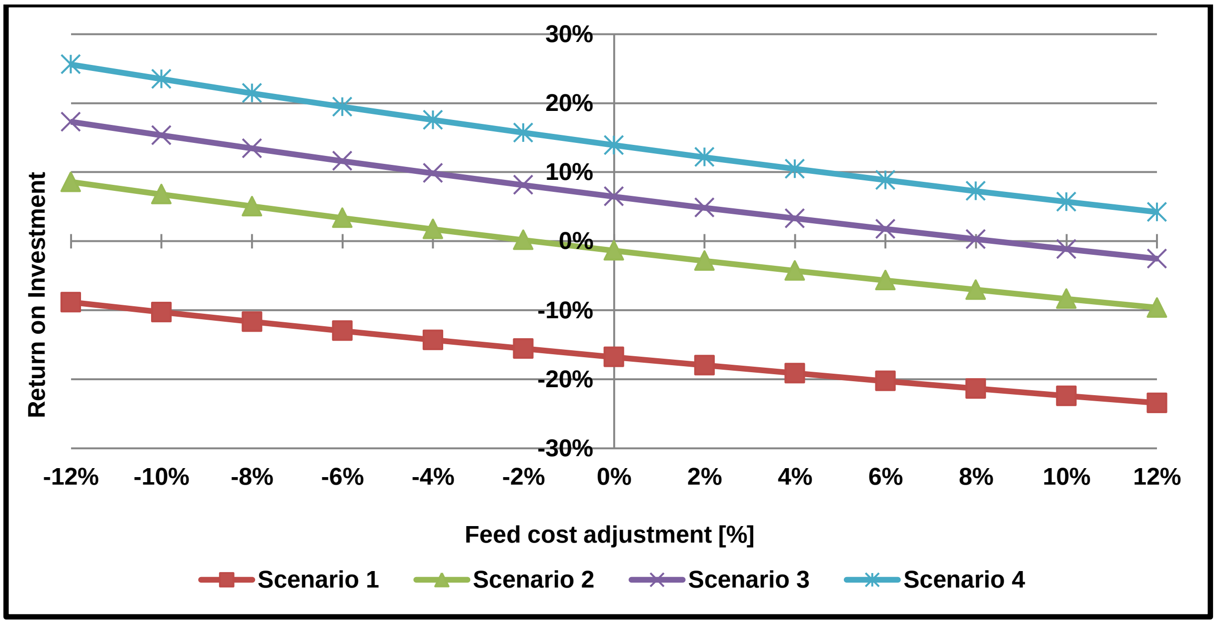


Figure 5.6 The effect of feeds cost adjustments on the scenarios' ROI

Feed costs adjustment at 10% ROI (Figure 5.6):

- Scenario 1: -33.57% adjustment to the base feed costs.
- Scenario 2: -13.53% adjustment to the base feed costs.
- Scenario 3: -4.29% adjustment to the base feed costs.
- Scenario 4: 4.57% adjustment to the base feed costs.

Potential discounts of 5% or more are available to cooperatives and smallholder pig farmers (Section 2.3.3). If a discount of 5% can be secured from Nova Feeds, Scenario 3 will be able to achieve sustainability. Furthermore, the feed costs can potentially be reduced by 4% if feed waste can be reduced.

However, even though Figure 5.4 shows that large decreases in feed costs may occur, a large average increase of more than 10.42% (10 year average) is probable. The average annual feed costs increase will render Scenario 3 unprofitable and Scenario 4 unsustainable.

5.2.3. Living costs

This section's sensitivity analysis investigates the effect of different household incomes (according to LSM groups) on the scenarios. Scenario 1 is excluded from this section because losses exceeding R 50 000 are experienced even with a monthly income of a LSM 2 household.

The South African Advertising Research Foundation (2012) shows the following monthly and annual incomes for LSM 2 to LSM 6 households:

- LSM 2: R 1 929 per month, R 23 148 per annum.
- LSM 3: R 2 258 per month, R 27 096 per annum.
- LSM 4: R 3 138 per month, R 37 656 per annum.
- LSM 5: R 4 165 per month, R 49 980 per annum.
- LSM 6: R 6 322 per month, R 75 864 per annum.

Figure 5.7 shows the living costs sensitivity analysis in terms of profits / losses and Figure 5.8 shows the living costs sensitivity analysis in terms of ROI.

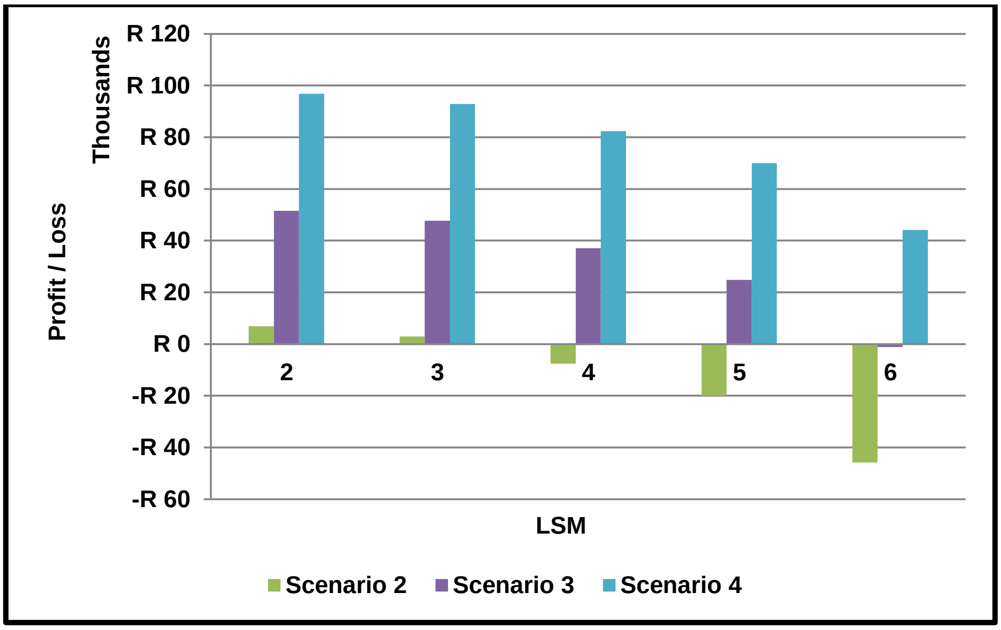


Figure 5.7 **The effect of monthly living costs adjustments on the scenarios' profit / loss**

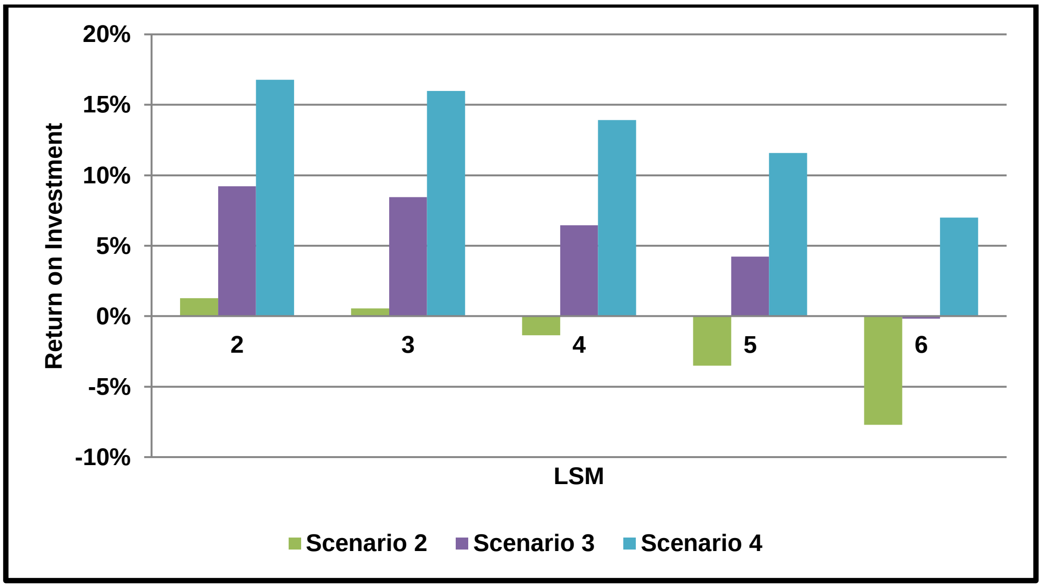


Figure 5.8 **The effect of monthly living costs adjustments on the scenarios' ROI**

Figure 5.7 show that Scenario 2 can achieve profitability for a LSM 2 and a LSM 3 income. However, even with an income rate of LSM 2, Scenario 2 remains unsustainable. Scenario 3 is profitable for the range of LSM 2 to 5 income rates. However, Scenario 3 is unable to achieve sustainability. Scenario 4 achieves profitability for the range of LSM 2 to 6 income rates and sustainability for the range of LSM 2 to 5 income rates.

5.2.4. Interest on loans

The "Interest on loans" sensitivity analysis explores the effect of an additional production cost in the form of interest on loans. This sensitivity analysis entails a range of interest rates (compounded annually) for a range of different loan amounts. The prime rate for November 2011 was 9% (South African Reserve Bank, 2012) and this interest rate will act as the median for this sensitivity analysis. The payback period is set at 30 years. Scenarios 1 and 2 are excluded from this section because they are operating at a loss in their base form. Refer to Table 5.2 for the start-up costs details for Scenario 3 and 4.

The following four loan amounts are evaluated for each scenario:

1. Start-up costs:
    - Scenario 3: = R 1 307 872.
    - Scenario 4: = R 1 325 866.
2. Non-production start-up costs and half of the first year's production costs:
    - Scenario 3: R 733 500 + R 574 372 / 2 = R 1 020 686.
    - Scenario 4: R 733 500 + R 592 366 / 2 = R 1 029 683.
3. The first year's production costs:
    - Scenario 3: = R 574 372.
    - Scenario 4: = R 592 366.
4. Half of the first year's production costs:
    - Scenario 3: R 574 372 / 2 = R 287 186.
    - Scenario 4: R 592 366 / 2 = R 296 183.

Start-up costs

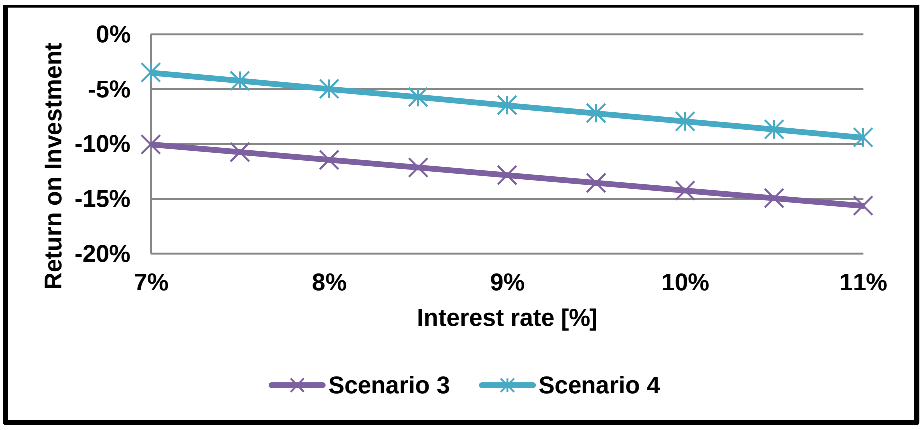


Figure 5.9 The effect of interest on loans for start-up costs on the scenarios' ROI

Profitability and sustainability evaluation for interest on loans (Figure 5.9):

- Scenario 3: Scenario 3 will not achieve profitability.
- Scenario 4: Scenario 4 will achieve profitability for an interest rate of less than 4.60%. However, sustainability is not achievable.

Non-production start-up costs and half of the first year's production costs

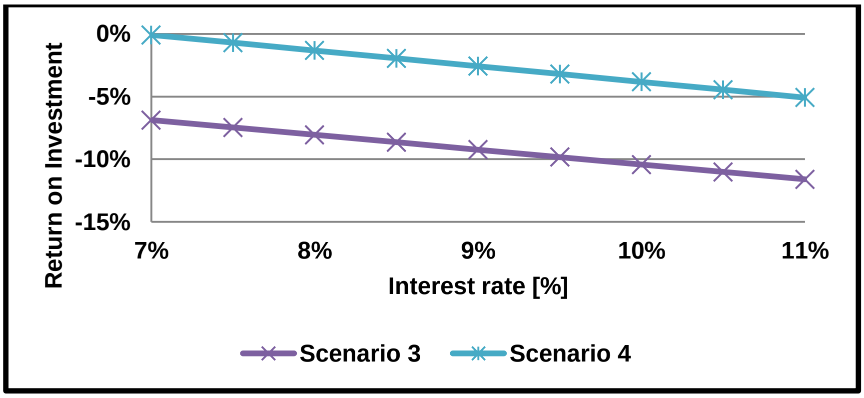


Figure 5.10 The effect of interest on loans for non-production start-up costs and half a year's production costs on the scenarios' ROI

Profitability and sustainability evaluation for interest on loans (Figure 5.10):

- Scenario 3: Scenario 3 will achieve profitability for an interest rate of less than 0.57%. However, sustainability is not achievable.
- Scenario 4: Scenario 4 will achieve profitability for an interest rate of less than 6.93%. However, sustainability is not achievable.

The first year's production costs

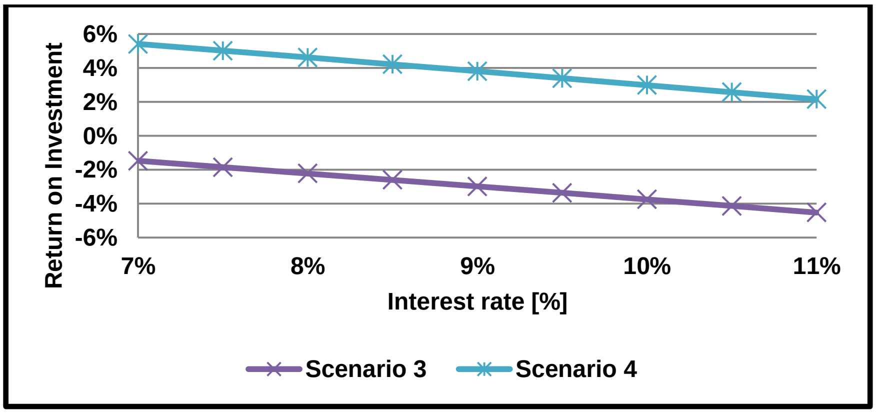


Figure 5.11 The effect of interest on loans for one year's production costs on the scenarios' ROI

Profitability and sustainability evaluation for interest on loans (Figure 5.11):

- Scenario 3: Scenario 3 will achieve profitability for an interest rate of less than 4.94%. However, sustainability is not achievable.
- Scenario 4: Scenario 4 will achieve profitability for an interest rate of less than 13.60%. Sustainability is achievable for interest rates of less than 0.48%.

Half of the first year's production costs

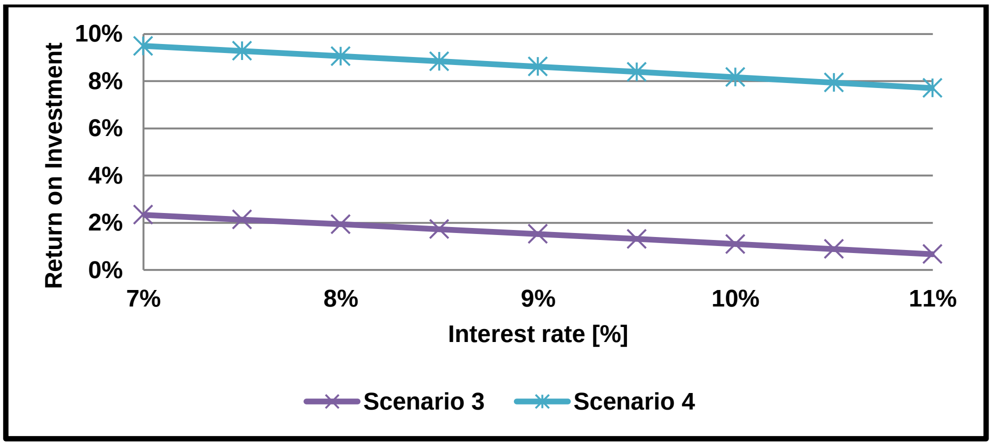


Figure 5.12 **The effect of interest on loans for half a year's production costs on the scenarios' ROI**

Profitability and sustainability evaluation for interest on loans (Figure 5.12):

- Scenario 3: Scenario 3 will achieve profitability for an interest rate of less than 12.55%. However, sustainability is not achievable.
- Scenario 4: Scenario 4 will achieve profitability for an interest rate of less than 27.79%. Sustainability is achievable for interest rates of less than 5.79%.

Interest on loans sensitivity analysis overview

The interest on loans sensitivity analysis shows that Scenario 3 can generate a profit for a loan amount of less than the first year's production costs. However, sustainability is not achievable. Scenario 4 can be profitable for a loan amount of less than the start-up costs. However, sustainability is potentially achievable only for loan amounts of less than half of the first year's production costs. This sensitivity analysis shows that it is unlikely for the scenarios to achieve sustainability if a loan production cost is included.

5.2.5. Unit size

In Section 2.3.4, pig production experts state that the minimum size of a profitable pig production unit is between 50 (Personal communication, Q. Nyoka, SAPPO's Portfolio Committee for Emerging Farmers, 6 August 2010) and 100 sows (Personal communication, J. Robinson, Private veterinary consultant, 05 December 2010).

The unit size sensitivity analysis considers the effect of increased pig farm sizes on the profitability and sustainability of the scenarios. All the production costs, except for the Living costs, increases as the the number of sows increase (Section 4.4.4).

Unit size adjustments

Figure 5.13 shows the effect of increased pig farm sizes on the scenarios' ROI.

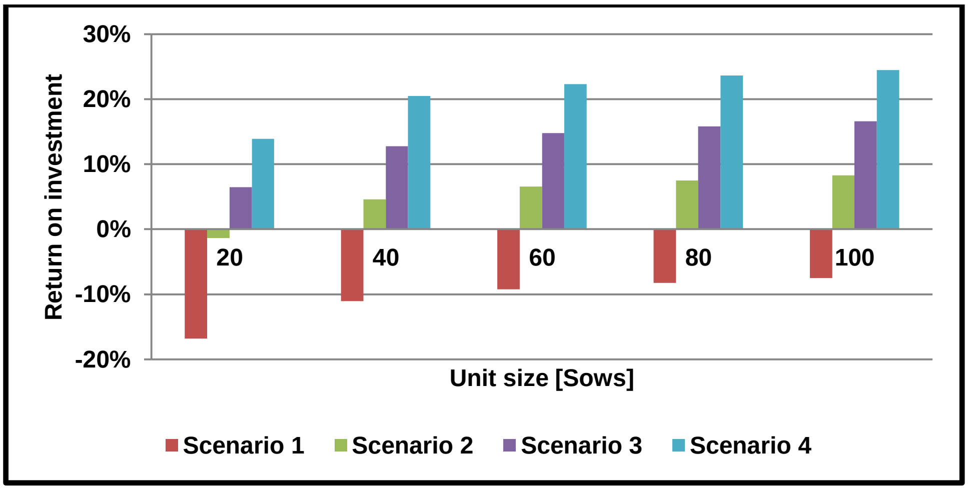


Figure 5.13 The effect of increased unit sizes on the scenarios' ROI

Results:

- Scenario 1: This scenario's production performance level is too low to take advantage of the increased unit size. Therefore, Scenario 1 is unable to generate a profit for the range of unit sizes.
- Scenario 2: Scenario 2 is able to generate a profit for a unit size of 23 sows or more. However, sustainability is not achievable within the sensitivity analysis range (20 to 100 sow units).
- Scenario 3: Scenario 3 can achieve profitability for the entire sensitivity analysis range (20 to 100 sow units) and sustainability for a unit size of 29 sows or more.
- Scenario 4: Scenario 4 can achieve profitability and sustainability for the entire sensitivity analysis range (20 to 100 sow units).

Unit size adjustments and associated feed discounts

Large pig farms have significant scope in terms of feed discount negotiations. The sensitivity analysis of unit size adjustments (with feed discounts) attempts to emulate the effect on a pig farm's ROI of feed discounts for increased unit sizes

This sensitivity analysis is the same as the unit size sensitivity analysis except for a 1.5% feed costs discount for each unit size increase of 20 sows beyond the 20 sow base unit size. Therefore, 0% feed costs discount is given for a 20 sow unit and 6% feed discount for a 100 sow unit (0.075% feed costs discount per sow beyond 20 sows).

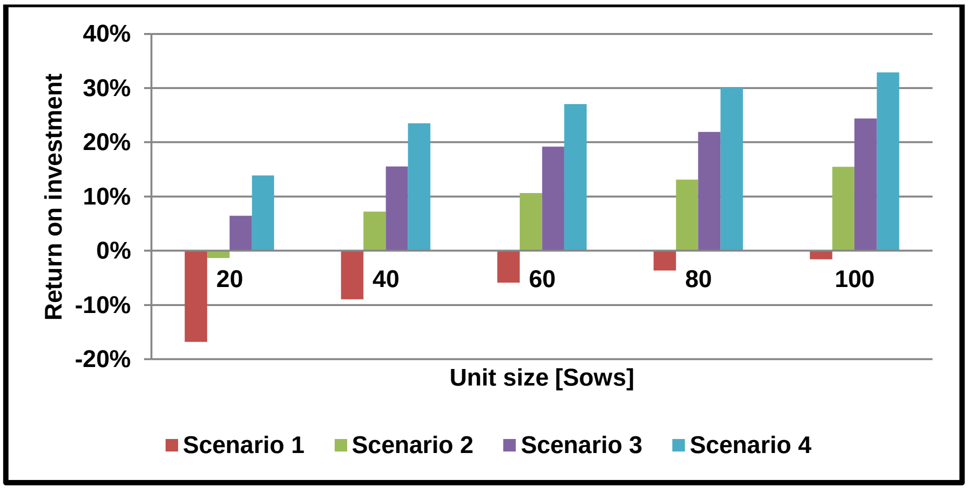


Figure 5.14 The effect of increased unit sizes (with feed discounts) on the scenarios' ROI

Results:

- Scenario 1: This scenario's production performance level is too low to take advantage of the increased unit size and feed costs discounts. Therefore, Scenario 1 is unable to generate a profit for the range of unit sizes.
- Scenario 2: Scenario 2 can achieve profitability for a unit size of 22 sows or more and sustainability for a unit size of 57 sows or more.
- Scenario 3: Scenario 3 can achieve profitability for the entire sensitivity analysis range (20 to 100 sow units) and sustainability for a unit size of 24 sows or more.
- Scenario 4: Scenario 4 can achieve profitability and sustainability for the entire sensitivity analysis range (20 to 100 sow units).

5.2.6. Growth rate

Pig genetics have substantially improved over the years. The growth rate sensitivity analysis (Figure 5.15) emulates the influence of faster growth rates (0 to 10% reduction in the number of days required to grow a pig from birth to 100 kg live slaughter weight) on each of the Scenarios' ROI.

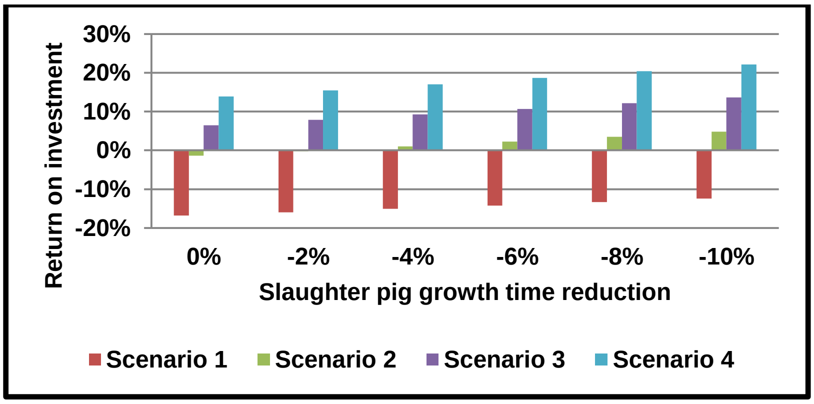


Figure 5.15 The effect of reduced growth time on the scenarios' ROI

The results show that Scenario 1 and 2 will not be able to achieve sustainability in the sensitivity analysis' growth time reduction range. Scenario 3 achieves sustainability for a growth time reduction of 5% or more and Scenario 4 achieves an ROI of more than 20% if a growth time reduction of 10% or more is achieved.

5.2.7. Live weight at slaughter

The commercial model's live weight at slaughter is 100 kg. The live weight at slaughter sensitivity analysis (Figure 5.16) considers the influence of lower and higher lives weights at slaughter (85 kg to 115 kg) on each of the Scenarios' ROI.

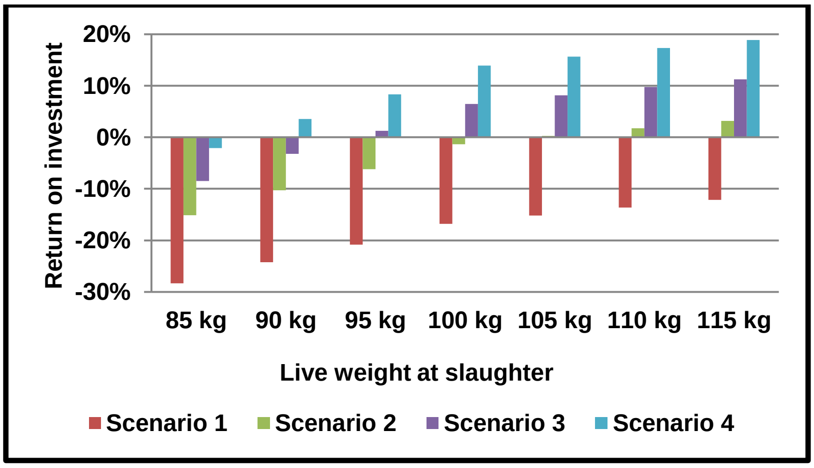


Figure 5.16 The effect of live weight at slaughter adjustments on the scenarios' ROI

Scenario 1 incurs losses for the range of live weights at slaughter and Scenario 2 incurs a loss for a live weight at slaughter of less than 104 kg. Scenario 3 incurs a loss for live weights at slaughter of less than 93 kg and Scenario 4 loses its sustainability potential for live weights at slaughter of less than 97 kg.

The results show that decreased feed costs because of lower live slaughter weights does not compensate for the loss of income as a result of lower carcass weights. Higher live weights at slaughter can potentially be more profitable. However, it will incur higher start-up costs (production pigs occupying pens for longer) and higher production costs (feed costs increase).

5.3. Evaluation overview

5.3.1. Scenario 1

Results summary:

- Pork prices: Large increases in the pork price are required to make Scenario 1 profitable (a 20.83% pork price increase) or sustainable (a 33.24% pork price increase). Trends show that the required increases are unlikely to occur.
- Feed costs: Large decreases in the cost of feed are required to make Scenario 1 profitable (a 23.15% feed cost decrease) or sustainable (a 33.57% feed cost decrease). Trends show that the required decreases are highly unlikely to occur except for the sporadic large decreases for certain years (with subsequent increases the following year).
- Living costs: Not applicable.
- Interest on loans: Not applicable.
- Unit size: Scenario 1 is unprofitable for the range of pig farm unit sizes evaluated (with and without feed costs discounts).
- Growth rate: Scenario 1 will not be able to achieve sustainability in the sensitivity analysis' growth time reduction range.
- Live weight at slaughter: Scenario 1 incurs losses for the range of live weights at slaughter.

5.3.2. Scenario 2

Results summary:

- Pork prices: A small pork price increase is required to make Scenario 2 profitable (a 1.41% pork price increase). Trends show that the required increase for profitability is a possible occurrence. However, a pork price increase of 11.78% is required for Scenario 2 to achieve sustainability. Trends show that the required increase for sustainability is unlikely to occur.
- Feed costs: A feed costs decrease is required to make Scenario 2 profitable (a 1.79% feed costs decrease) or sustainable (a 13.53% feed costs decrease). Trends show that the required decreases are unlikely to occur.
- Living costs: Scenario 2 is profitable for LSM 2 and LSM 3 living cost levels. However, this scenario is not sustainable for any of the LSM groups.
- Interest on loans: Not applicable.
- Unit size: Scenario 2 is profitable for pig farm sizes of 23 sows or more (without feed discounts). However, sustainability is not achievable within the analysis range. If feed costs discounts are provided, Scenario 2 can be profitable for a pig farm size of 22 sows or more and sustainable for pig farm sizes of 57 sows or more.
- Growth rate: Scenario 2 will not be able to achieve sustainability in the sensitivity analysis' growth time reduction range.
- Live weight at slaughter: Scenario 2 incurs a loss for a live weight at slaughter of less than 104 kg.

5.3.3. Scenario 3

Results summary:

- Pork prices: A 6.19% pork price decrease would be required to make Scenario 3 unprofitable and a 3.39% pork price increase is required to make Scenario 3 sustainable. Trends show that the pork price increase required for sustainability is a possible occurrence.
- Feed costs: An increase in feed costs is required to make Scenario 3 unprofitable (a 8.40% feed costs increase) and a feed costs decrease is required to make Scenario 3 sustainable (a 4.29% feed costs decrease). Trends show that the decrease required for sustainability is unlikely to occur.
- Living costs: Scenario 3 is profitable for LSM 2 to 5 living cost levels. However, this scenario is not sustainable for any of the LSM groups.
- Interest on loans: The interest on loans sensitivity analysis shows that Scenario 3 can generate a profit for a loan amount of less than the first year's production costs. However, sustainability is not achievable.

Results summary (continued):

- Unit size: Scenario 3 can achieve profitability for the entire sensitivity analysis range (20 to 100 sow units) and sustainability for a unit size of 29 sows or more. With feed costs discounts, Scenario 3 can achieve profitability for the entire sensitivity analysis range (20 to 100 sow units) and sustainability for a unit size of 24 sows or more.
- Growth rate: Scenario 3 achieves sustainability for a growth time reduction of 5% or more.
- Live weight at slaughter: Scenario 3 incurs a loss for live weights at slaughter of less than 93 kg.

5.3.4. Scenario 4

Results summary:

- Pork prices: A decrease in the pork price would be required to make Scenario 4 unprofitable (a 12.43% pork price decrease) or unsustainable (a 3.49% pork price decrease). Trends show that the potential decreases are highly unlikely to occur.
- Feed costs: A feed costs increase is required to make Scenario 4 unprofitable (a 17.93% feed costs increase) or unsustainable (a 4.57% feed costs increase). Trends show that the decreases are unlikely to occur.
- Living costs: Scenario 4 is profitable for LSM 2 to 6 living cost levels and sustainable for LSM 2 to 5 living cost levels.
- Interest on loans: Scenario 4 can be profitable for a loan amount of less than the start-up costs. However, sustainability is potentially achievable only for loan amounts of less than half of the first year’s production costs.
- Unit size: Scenario 4 can achieve profitability and sustainability for the entire sensitivity analysis range (20 to 100 sow units).
- Growth rate: Scenario 4 can achieve an ROI of more than 20% if a growth time reduction of 10% or more is achieved.
- Live weight at slaughter: Scenario 4 loses its sustainability potential for live weights at slaughter of less than 97 kg.

6. Findings

This chapter involves a discussion of the positive and negative aspects of the commercial standard smallholder pig farm endeavour, as identified in chapter 2 (Literature Study), chapter 4 (Analysis) and chapter 5 (Evaluation).

6.1. Positive findings

This section entails a consideration of beneficial aspects of the proposed commercial standard smallholder pig farm.

6.1.1. Household income

The Scenarios provide a monthly household income of R 3 138. Additionally, the monthly income can be supplemented by a small part of the annual profit of R 37 102 (Scenario 3) or R 82 359 (Scenario 4). However, the profits should be saved to safeguard the farm against potential negative price changes (decreased pork price or increased feed costs). Additionally, employment is provided through the commercial pig farm’s part-time labour requirement.

6.1.2. Food production

Scenario 2 (base model) produces 30 831 kg of pork per year (386.53 slaughter pigs x 77.13 kg pork + 6.67 culled pigs x 152.60 kg pork). Directorate Agricultural Statistics (2012) states that the 2011 South African per capita pork consumption was 4.6 kg. Therefore, a 20 sow pig farm can produce sufficient pork for the needs of 6 702 people (30 831 kg of pork / 4.6 kg pork) per year.

6.1.3. Supporting local business

The commercial pig farm can support local businesses, such as the feed mill (Nova Feeds), veterinary suppliers, general suppliers and construction material suppliers.

6.1.4. Animal welfare

The commercial pig farm will have a higher animal welfare level than the community’s current smallholder pig farms. The animal welfare is addressed by the improvement in the quality of feed, biosecurity, water availability, housing, veterinary supplies and pig production training.

6.1.5. Pork industry biosecurity

The biosecurity of the pork industry on a regional level improves with each increase of biosecurity levels on smallholder pig farms.

6.2. Negative findings

This section entails a consideration of the unfavourable aspects of the proposed commercial standard smallholder pig farm.

6.2.1. Sustainability

The evaluation (Chapter 5) has shown that the production performance levels of Scenarios 3 to 4 could potentially be profitable and sustainable. However, the feed costs are likely to increase by a larger margin (10.42% for the 10 year average increase per year) than the pork prices (4.67% for the 10 year average increase per year). A 1% increase in the base model's pork price increases the ROI by 0.98%, while a 1% increase of feed costs decreases the ROI by 0.72%. The combined influence on the ROI of the average annual pork price and feed costs increases amounts to a decrease of 2.93% (4.67% x 0.98 - 10.42% x 0.72). Therefore, the influence of changes to pork price increases is not sufficient to negate the effect of feed costs increases.

The potential annual feed costs increase presents a threat to the sustainability of the proposed commercial standard smallholder pig farm.

6.2.2. High start-up costs

The estimated start-up costs for a 20 sow commercial farm ranges from R 1 201 354 to R 1 325 866 between the different scenarios. As discussed in Section 5.2.4, only Scenario 4 can partially fund start-up costs (half of the annual production costs) while remaining sustainable.

6.2.3. Learning curve

There is a high probability that the pig farmers will not be able to initially achieve the Scenarios 2 to 4 production performance levels. The longer the pig farmers take to achieve the necessary production performance levels, the more funding they will require to remain operational.

6.2.4. Disease outbreaks

If a disease outbreak should occur and the farmer is unable to identify and negate it early enough, a large percentage of the herd could become infected. This occurrence can lead to financial losses that can bankrupt the pig farm.

6.2.5. Pig production unit size

Experts state that the minimum size for a profitable pig production farm is between 50 (Personal communication, Q. Nyoka, SAPPO's Portfolio Committee for Emerging Farmers, 6 August 2010) and 100 sows (Personal communication, J. Robinson, Private veterinary consultant, 05 December 2010). The reasoning is that a particular minimum unit size is required to gain the advantages of economies of scale (such as discounts on feed costs by the procurement of large volumes of feed) and to secure abattoir contracts (a constant supply of slaughter pigs is a requirement of abattoir contracts).

The ROI of increased pig farm sizes is shown in Section 5.2.5. The scenario's ROI increased by a large margin for every 20 sows that were added to the farm. The constraints that keep the pig farmers from increasing their herd are a lack of (Section 4.3.1):

- Experience: The farmers need to have experience with larger herd sizes.
- Funding: Funding is required for increased housing and feed costs.
- Land space: The current land area available per farmer is not deemed sufficient for a farm size of more than 20 sows.
- Labour: Limited labour is available.

The abovementioned constraints will have to be addressed before the case study community will be able to have larger commercial pig farms.

7. Conclusion

The research question, acting as the point of departure for this study, is: “Is it economically feasible for a smallholder piggery to convert to a commercial standard?” A pig farm is not economically feasible unless it is sustainable (ROI of 10% or more) in order to counteract potential increased costs or decreased income. The positive and negative findings provided a perspective on the potential reasons why the pig farm can be considered as either economically feasible or not.

The highest production performance scenarios (Scenario 3 and 4) are profitable and potentially sustainable if erratic negative parameter changes (parameter changes that decrease the ROI) are absent. However, the two scenarios require a high production performance level and by extension, a high level of pig production expertise. The smallholder pig farmers are unlikely to have the required skills unless they are provided with fulltime pig production expert support, given formal training or have gained formal pig farming experience by being previously employed at a commercial pig farm.

Economic feasibility is achievable for Scenarios 2, 3 and 4 for increased unit sizes. Scenario 2 requires a pig farm size (with feed costs discounts) of 57 sows or more to achieve sustainability. This finding correlates with the experts’ view that a pig farm needs to have a minimum size of between 50 and 100 sows (Section 6.2.5). The benefits of economies of scale through improved veterinary supplies utilisation and feed costs discounts through bulk purchases are the primary benefits of increased unit sizes.

The case study’s 20 sow commercial pig farm is not deemed as economically feasible. This economic feasibility finding pertains only to the case study community. Further research is required before smallholder commercial pig farmers (on a regional or national level) can be deemed economically feasible or not.

7.1. Summary of contributions

7.1.1 The commercial model improvement endeavour can be compared to the return on investment of other agriculture support initiatives.

7.1.2 The study gives potential entrants to the pork production industry a picture of the challenges facing smallholder pig producers (biosecurity, heating, water shortages, feeding, training, etc.) as well as the financially sensitive aspects (pork prices and feed costs). These aspects can be seen as typical issues facing South African smallholder pig producers.

7.1.3 The findings show that if sufficient support in the way of financial and pig production expertise is provided, a commercially feasible smallholder pig farm is potentially attainable.

7.2. Future research

7.2.1 A potential limitation of this study includes the timeframe of each budgeting period (the current model has an annual budgeting timeframe). More accurate planning would be possible if the timeframe were reduced to a shorter timeframe (e.g. a month) and if the time value of money were considered.

7.2.2 The model's non-financial benefits require a more thorough investigation. The true value of the proposed endeavour requires an evaluation of the achievable benefits for the South African pig farmers and consumers in terms of biosecurity improvement, food safety and animal welfare.

7.2.3 Few or no studies are currently being conducted on South African smallholder emerging commercial pig farmers' operations (less than 100 sows) addressing aspects such as their production performance or their success rate. Further research is required to determine an ideal pilot site. The pilot site will be determined by considering where it is most needed (region with the highest poverty and food insecurity), where support is possible (funding and training), water and markets are available, the climate is suitable, vital locations are nearby (a feed supplier and an abattoir), and there is adequate quality feed available.

8. References

ABSA Vehicle Management Solution (Pty) Ltd. & the Automobile Association of South Africa, 2011. Calculating the Operating Cost of a Vehicle. [Online]. Available at: http://www.aa.co.za/content/62/vehicle-operating-costs/ [Accessed: 2011-11-01].

Agricultural Research Council, 2008. Annual Report 2007 - 2008, Agricultural Research Council.

Ajala, M. K., Adesehinwa, A. O. & Mohammed, A. K., 2007. Characteristics of smallholder pig production in Southern Kaduna area of Kaduna State, Nigeria. American-Eurasian Journal of Agricultural & Environmental Sciences, 2(2), pp. 182 - 188.

Aland, A. & Madec, F., 2009. Sustainable animal production - The challenges and potential developments for professional farming. 1st edition. The Netherlands. Wageningen Academic Publishers.

Aliber, M. & Hart, T. G., 2009. Should subsistence agriculture be supported as a strategy to address rural food insecurity? Agrekon, 48(4), pp. 434 - 458.

Altman, M., Hart, T. G. & Jacobs, P. T., 2009. Household Food Security status in South Africa. Agrekon, 48(4), pp. 345 - 361.

Am-in, N., Tantasuparuk, W. & Techakumphu, M., 2010. Comparison of artificial insemination with natural mating on smallholder farms in Thailand. Tropical Animal Health and Production, 42(5), pp. 921 - 924.

Andersen, I. L., Berg, S. & Bøe, K. E., 2005. Crushing of piglets by the mother sow (Sus scrofa) — purely accidental or a poor mother? Applied Animal Behaviour Science, Volume 93, pp. 229 – 243.

Automobile Association of South Africa, 2011. Fuel Pricing for 2011. [Online]. Available at: http://www.aa.co.za/content/59/fuel-pricing/ [Accessed: 2011-11-15].

Beltrán-Alcrudo, D., Lubroth, J., Depner, K. & De La Rocque, S., 2008. African swine fever in the Caucasus. [Online]. Available at: ftp://ftp.fao.org/docrep/fao/011/aj214e/aj214e00.pdf [Accessed: 2011-08-09].

Bravo-Ortega, C. & Lederman, D., 2005. Agriculture and national welfare around the world: Causality and international heterogeneity since 1960.

Bruwer, G. G., 1992. The evaluation of pig carcasses for the development of a classification system.

Chiduwa, G., Chimonyo, M., Halimani, T. E., Chisambara, S. R. & Dzama, K., 2008. Herd dynamics and contribution of indigenous pigs to the livelihoods of rural farmers in a semi-arid area of Zimbabwe. Tropical Animal Health and Production, 40(2), pp. 125 - 136.

Chmielewska, D. & Souza, D., 2010. Market alternatives for smallholder farmers in food security initiatives: Lessons from the Brazilian food acquisition programme. United Nations Development Programme.

Cilliers, F., 2006. Biogas ontwerp en bedryfshandleiding, Silverton, Pretoria, Republic of South Africa: Instituut vir Landbou-ingenieurswese, ’n Instituut van die Landbounavorsingsraad (LNR).

City of Cape Town, 2006. Brand new fresh produce market for Cape Town. [Online]. Available at: http://www.capegateway.gov.za/eng/pubs/news/2006/nov/147918 [Accessed: 2011-06-11].

Commodico Distributors (Pty) Ltd., 2008. Business plan for Walk on Water CC. South African Pork Producers Organisation.

Constitutional Court, 1996. Constitution of the Republic of South Africa, Pretoria, Republic of South Africa: Republic of South Africa.

Costales, A., Delgado, C., Catelo, M. A., Lapar, M. L., Tiongco, M., Ehui, S. & Bautista, A. Z., 2007. Scale and access issues affecting smallholder hog producers in an expanding peri-urban market, Southern Luzon, Philippines, Washington, D.C. U.S.A. International Food Policy Research Institute.

Costard, S., Porphyre, V., Messad, S., Vidon, S., Vidon, H., Roger, F. & Pfeiffer, D. U., 2009. Multivariate analysis of management and biosecurity practices in smallholder pig farms in Madagascar. Preventive Veterinary Medicine, Volume 92, pp. 199 - 209.

Cousins, B., 2010. What is a smallholder? Class-analytic perspectives on small-scale farming and agrarian reform in South Africa, South Africa.

Department of Agriculture, 2002. The Integrated Food Security Strategy for South Africa, Pretoria.

Department of Agriculture, 2011. Agriculture Marketing Extension Training Papers No 7: Livestock marketing. [Online]. Available at: http://www.daff.gov.za/docs/GenPub/7Livestock.pdf
[Accessed: 2011-07-14].

Department of Labour, 2011. Sectoral Determination 13: Farm Worker Sector. [Online]. Available at: http://www.labour.gov.za/DOL/legislation/sectoral-determinations/sectoral-determination-13-farm-worker-sector [Accessed: 2011-12-01].

Dhuyvetter, K. C., Tokach, M. D., Dritz, S. S. & De Rouchey, J., 2011. Farrow-to-Finish Swine Cost-Return Budget, Manhattan, USA: Kansas State University Agricultural Experiment Station and Cooperative Extension Service.

Directorate Marketing, 2010a. A profile of the South African beef market value chain, Arcardia, Republic of South Africa. Department of Agriculture, Forestry and Fisheries.

Directorate Marketing, 2010b. A profile of the South African mutton market value chain, Arcardia, Republic of South Africa. Department of Agriculture, Forestry and Fisheries.

Directorate Marketing, 2010c. A profile of the South African pork market value chain, Arcadia, Republic of South Africa: Department of Agriculture, Forestry and Fisheries.

Directorate of Agricultural Statistics, 2010. Abstract of Agricultural Studies, Pretoria, Republic of South Africa.

Du Toit, D. C., Ramonyai, M. D., Lubbe, P. A. & Ntushelo, V., 2011. Food Security, South Africa. Directorate Economics Services, Department of Agriculture, Forestry and Fisheries.

Eskom, 2011. Eskom - Tariffs and charges. [Online]. Available at: http://www.eskom.co.za/content/priceincrease2011.pdf [Accessed: 2011-11-03].

Ethical Trading Initiative, 2005. ETI smallholder guidelines - Recommendations for working with smallholders, London, United Kingdom.

European Food Safety Authority, 2009. Analysis of the baseline survey on the prevalence of Salmonella in holdings with breeding pigs in the EU, 2008 - Part A: Salmonella prevalence estimates. EFSA Journal, 7(12), pp. 1377 - 1470.

First National Bank, 2012. FNB AgriCommodities. [Online]. Available at: https://www.fnbagricomms.co.za/MainPage/AgricWeekly.aspx [Accessed: 2012-08-17].

Food and Agriculture Organization of the United Nations, 2004. State of Food Insecurity in the World, Monitoring progress towards the World Food Summit and Millennium Development Goals, Rome, Italy.

Food and Agriculture Organization of the United Nations, 2008. The state of Food and Agriculture, Biofuels: Prospects, risk and opportunities, Rome, Italy.

Food and Agriculture Organization of the United Nations, 2010. FAOSTAT. [Online]. Available at: http://faostat.fao.org/site/339/default.aspx [Accessed: 2010-04-12].

Froese, C., 2003. Water Usage and Manure Production Rates in Today's Pig Industry. Advances in Pork Production, Volume 14, pp. 215.

Gous, R. M., Morris, T. R. & Fischer, C., 2006. Mechanistic Modelling in Pig And Poultry Production. CABI Publishing.

Hamilton, D. N., Ellis, M., Wolter, B. F., Schinckel, A. P. & Wilson, E. R., 2003. The growth performance of the progeny of two swine sire lines reared under different floor space allowances. Journal of Animal Sciences, Volume 81, pp. 1126 - 1135.

Herrero, J. M., 2011. Low cost biodigesters to produce biogas and natural fertilizer from organic waste. [Online]. Available at: http://www.ideassonline.org/innovations/brochureView.php?id=76 [Accessed: 2011-10-12].

Humane Farm Animal Care, 2004. Standards Manual: Beef Cattle, Herndon, USA.

Humane Farm Animal Care, 2005. Standards Manual: Sheep, Herndon, USA.

Humane Farm Animal Care, 2008. Standards Manual: Pigs, Herndon, USA.

International Livestock Research Institute, 2011. The smallholder pig value chain: An opportunity for growth and poverty reduction, Kampala, Uganda, Nairobi, Kenya. International Livestock Research Institute.

Kagira, J. M., Kanyari, P. W., Maingi, N., Githigia, S. M., Ng'ang'a, J. C. & Karuga, J. W., 2010. Characteristics of the smallholder free-range pig production system in western Kenya. Tropical Animal Health and Production, Volume 42, pp. 865 – 873.

Key, N. & McBride, W., 2007. The changing economics of U.S. hog production, USA. United States Department of Agriculture.

Kyriazakis, I. & Whittemore, C. T., 2006. Whittemore's science and practice of pig production. 3rd Edition. Blackwell Publishing.

Lapar, L. & Staal, S., 2010. Competitiveness of smallholder pig producers in Vietnam, Improving the Competitiveness of Pig Producers in Vietnam, Nairobi, Kenya. International Livestock Research Institute.

Louw, A., Geyser, M. & Schoeman, J., 2011. Pork and broiler industry supply chain study with emphasis on feed and feed related issues. National Agriculture Marketing Council.

Maharjan, K. L. & Fradejas, C. C., 2006. Role of Cooperative in Improving Accessibility to Production Resources and Household Economy of Backyard Pig Raisers in Batangas, Philippines. Gold Coast, Australia. pp. 1 - 4.

Manona, S. S., 2005. Smallholder agriculture as local economic development (LED) strategy in rural South Africa: Exploring prospects in Pondoland, Eastern Cape. University of Western Cape.

McGlone, J. & Pond, W. G., 2003. Pig production: biological principles and applications. Cengage Learning.

McPhee, C. P., 2001. Pig Genetics - An overview. Ho Chi Minh City, Vietnam.

Moser, M. A., Randall, M. & Gold, L., 2005. Biomass Feasibility Study, Berkeley, USA. RCM Digesters, Inc.

Mpofu, I. & Makuza, S. M., 2003. Pig Production Science and Technology. First Editio. United Kingdom. Upfront Publishing.

Mtileni, B. J., Phitsane, P. M. & Nengovhela, N. B., 2006. Developing an integrated support system to achieve a continuous profitability amongst the Resource Poor Farmers of North West, Limpopo and Mpumalanga provinces of South Africa: A case study. South African Society for Animal Science, Volume 7, pp. 1 - 4.

Nompozolo, S., 2000. An analysis of the characteristics and constraints of smallholder commercial farmers in the Transkei region, Eastern Cape, South Africa, Alice, Republic of South Africa. University of Fort Hare.

Normile, D., 2005. Infectious Diseases: WHO probes deadliness of China's pig-borne disease. Science, Volume 309, pp. 1308 - 1309.

Nyoka, Q., 2009. Guidelines for Emerging Pig Farmers, Pretoria, Republic of South Africa. South African Pork Producers Organization.

Oosterwijk, G., Van Aken, D. & Vongthilath, S., 2003. A Manual on Improved Rural Pig Production, Vientiane, Lao PDR: Department of Livestock and Fisheries, Ministryof Agriculture and Forestry.

Petrus, N. P., Mpofu, I., Schneider, M. B. & Nepembe, M., 2011. The constraints and potentials of pig production among communal farmers in Etayi Constituency of Namibia. Livestock Research for Rural Development, 23(7).

Phengsavanh, P., Ogle, B., Stür, W., Frankow-Lindberg, B. E. & Lindberg, J. E., 2011. Smallholder Pig Rearing Systems in Northern Lao PDR. Asian - Australasian Journal of Animal Sciences, 24(6), pp. 867 - 874.

PIC, 2002. Camborough 22 - A Guide to Commercial Improvement. [Online]. Available at: http://www.kanhym.co.za/pages/articles_gilts.htm [Accessed: 2010-05-07].

Pieterse, E., 2006. Effects of increased slaughter weight of pigs on pork production, Stellenbosch, Republic of South Africa. University of Stellenbosch.

PLAAS, 2011. Research Report 41, Strategies to support South African smallholders as a contribution to government’s second economy strategy, Volume 2: Case studies, Cape Town, Republic of South Africa: Institute for Poverty, Land and Agrarian Studies (PLAAS), University of the Western Cape.

Pluske, J. R., Le Dividich, J. & Verstegen, M. W., 2003. Weaning the pig: concepts and consequences. Wageningen Academic Publishers.

Quiniou, N., Courboulay, V., Salaun, Y. & Chevillon, P., 2010. Impact of the non castration of male pigs on growth performance and behaviour - Comparison with barrows and gilts. Heraklion, Crete Island, Greece, Institut du Porc.

Randolph, T. F., 2002. The economic impact of foot and mouth disease control and eradication in the Philippines. Rev Sci Tech, 21(3), pp. pp.645 - 661.

Red Meat Industry Forum, 2012. Pork/Pigs. [Online]. Available at: http://www.redmeatsa.co.za/market-indicators/pigs-pork [Accessed: 2012-09].

Robinson, J., 2004. Biosecurity: A long word for a simple idea. [Online]. Available at: http://www.sapork.biz/biosecurity-a-long-word-for-a-simple-idea/ [Accessed: 2010-07-02].

Robinson, J., 2009. A new look at Biosecurity. [Online]. Available at: http://www.sapork.com/art3apr09.html [Accessed: 2010-06-10].

Rothschild, M. F. & Ruvinsky, A., 2011. The Genetics of the Pig. 2nd edition. Wallingford, Oxfordshite, United Kingdom. CABI.

Saha, R., Ghosh, P. K., Mishra, V. K. & Bujarbaruah, K. M., 2007. Low-cost micro-rainwater harvesting technology (Jalkund) for new livelihood of rural hill farmers. Current Science, 92(9), pp. 1258 - 1265.

Saving Water SA, 2011. Cape Town water and sanitation tariff 2011 to 2012. [Online]. Available at: http://www.savingwater.co.za/2011/03/29/07/cape-town-water-and-sanitation-tariff-2011-to-2012/ [Accessed: 2011-06-20].

Seavey, D. C. & Porter, J. C., 2009. Housing and space guidelines for livestock, Durham, USA.

Smith, L. F., Beaulieu, A. D. & Patience, J. F., 2004. The impact of feeder adjustment and group size & floor space allowance on the performance of nursery pigs. J Swine Health Prod, 12(3), pp. 111-118.

South African Advertising Research Foundation, 2012. www.saarf.co.za. [Online]. Available at: http://www.saarf.co.za/lsm-descriptions/2012/LSMDescriptions2012.pptx [Accessed: 2012-05-15].

South African Pork Producers Organisation, 2009. The South African Pork Industry, the big picture.

South African Reserve Bank, 2012. South African Reserve Bank. [Online]. Available at: http://www.resbank.co.za [Accessed: 2012-02-15].

Soy, S. K., 1997. The Case Study as a Research Method. [Online]. Available at: http://www.gslis.utexas.edu/~ssoy/usesusers/l391d1b.htm [Accessed: 2010-03-02].

Spencer, A., 2010. Establishing a piggery. [Online]. Available at: http://www.dpi.qld.gov.au/27_4085.htm [Accessed: 2010-03-12].

Statistics South Africa & United Nations Development Programme, 2010. Millennium development goals - Country report 2010, Republic of South Africa.

Statistics South Africa, 2008. Labour Force Survey: March series 2001 to 2007, Pretoria, South Africa.

Statistics South Africa, 2010. General household survey 2009, Pretoria.

Statistics South Africa, 2011. General household survey 2010, Pretoria.

Statistics South Africa, 2011. Quarterly Labour Force Survey: Quarter 3, Pretoria, South Africa.

Swedish Cooperative Centre Africa & Agromisa, 2010. Pig Keeping for Small-scale Farmers - Book 1 - Housing & Equipment, Rearing Systems and Feeding. Revised version ed. Lusaka, Zambia. Mujalo Printers and Stationers Ltd.

Tisdell, C., 2010. Economic Theory, Applications and Issues - An Economic Study of Small Pigholders in Vietnam: Some Insights Gainedd and the Scope for Further Research, Australia.

Turton, J., 2002. Swill Feeding is Banned in Australia. [Online]. Available at: http://www.dpi.vic.gov.au/agriculture/animals-and-livestock/pigs/pig-health-and-welfare/swill-feeding-banned [Accessed: 2010-09-12].

Uaboi-Egbenni, P. O., Bessong, P. O., Samie, A. & Obi, C. L., 2011. Prevalence, haemolysis and antibiograms of Campylobacters isolated from pigs from three farm settlements in Venda region, Limpopo province, South Africa. African Journal of Biotechnology, 10(4), pp. 703 - 711.

United Nations Development Programme, 2006. Human Development Report 2006 - Beyond scarcity: Power, poverty and the global water crisis, New York, USA.

Wabacha, J. K., Maribei, J. M., Mulei, C. M., Kyule, M. N., Zessin, K. H. & Oluoch-Kosura, W., 2004. Health and production measures for smallholder pig production in Kikuyu Division, central Kenya. Preventive Veterinary Medicine, Volume 63, pp. 197 - 210.

Waddilove, J., 2008. Biosecurity, air quality and aerial spread of pathogens in swine production, USA.

Whittington, L., 2005. Tips for saving Water. [Online]. Available at: http://www.thepigsite.com/articles/1320/tips-for-saving-water [Accessed: 2010-03-19].

Wiggins, S., 2009. Can the smallholder model deliver poverty reduction and food security for a rapidly growing population in Africa?, Rome, Italy: Food and Agriculture Organization of the United Nations.

Wiseman, J., Varley, M. A. & Kemp, B., 2003. Perspectives in pig science. Nottingham University Press.

World Bank, 2007. Agriculture for Development, World Development Report 2008, USA.

Yin, R. K., 2002. Case Study Research: Design and Methods. Third Edition, Applied Social Research Methods Series, Volume 5 ed. London, United Kingdom. Sage Publications.

Zainal, Z., 2007. Case study as a research method. Jurnal Kemanusiaan, Volume 9.

9. Addendum

9.1. Solar power quotations

Three quotations are generated for a solar powered system capable of powering a single 175 Watt heating lamp for either 24 hours per day or 12 hours per day (refer to Table 9.1).

Table 9.1 Comparison of 175 Watt single heating lamp solar power costs (for 24 and 12 hours per day) between three companies

	Sunflare		**Sustainable.co.za**		**Sinetech**	
	24h	**12h**	**24h**	**12h**	**24h**	**12h**
Solar panels	R 58 186	R 29 093	R 34 200	R 21 375	R 24 314	R 12 157
Batteries	R 57 456	R 28 728	R 13 488	R 10 116	R 15 554	R 7 777
Regulator	N/A	N/A	R 4 544	R 1 485	R 1 003	R 862
Inverter	R 2 394	R 2 394	R 4 577	R 3 699	R 376	R 376
Installation, cabling and brackets[1]	R 13 156	R 8 573	R 10 733	R 9 120	R 17 738	R 11 047
Total[2]	**R 131 191**	**R 68 788**	**R 67 543**	**R 45 796**	**R 58 986**	**R 32 219**

[1] A cost of R 3500 is added to the "Installation, cabling and brackets" costs for Sunflare and Sinetech. This cost is based on Sustainable.co.za's estimated installation cost.

[2] All costs include VAT.

Source: Personal communication, Du Plessis, E., Sunflare, 7 March 2011; Hüllermeier, K., Sinetech, 3 March 2011; Lee-Wright, A., Sustainable.co.za, 8 March 2011

The average cost (averaged between the three companies) for a 24 or 12 hours per day electricity supply for a single 175 Watt heating lamp:

- 12h: R 48 934.12
- 24h: R 85 906.60

The expected operating lifetime for the system is (Personal communication, Du Plessis, E., Sunflare, 7 March 2011; Hüllermeier, K., Sinetech, 3 March 2011; Lee-Wright, A., Sustainable.co.za, 8 March 2011):

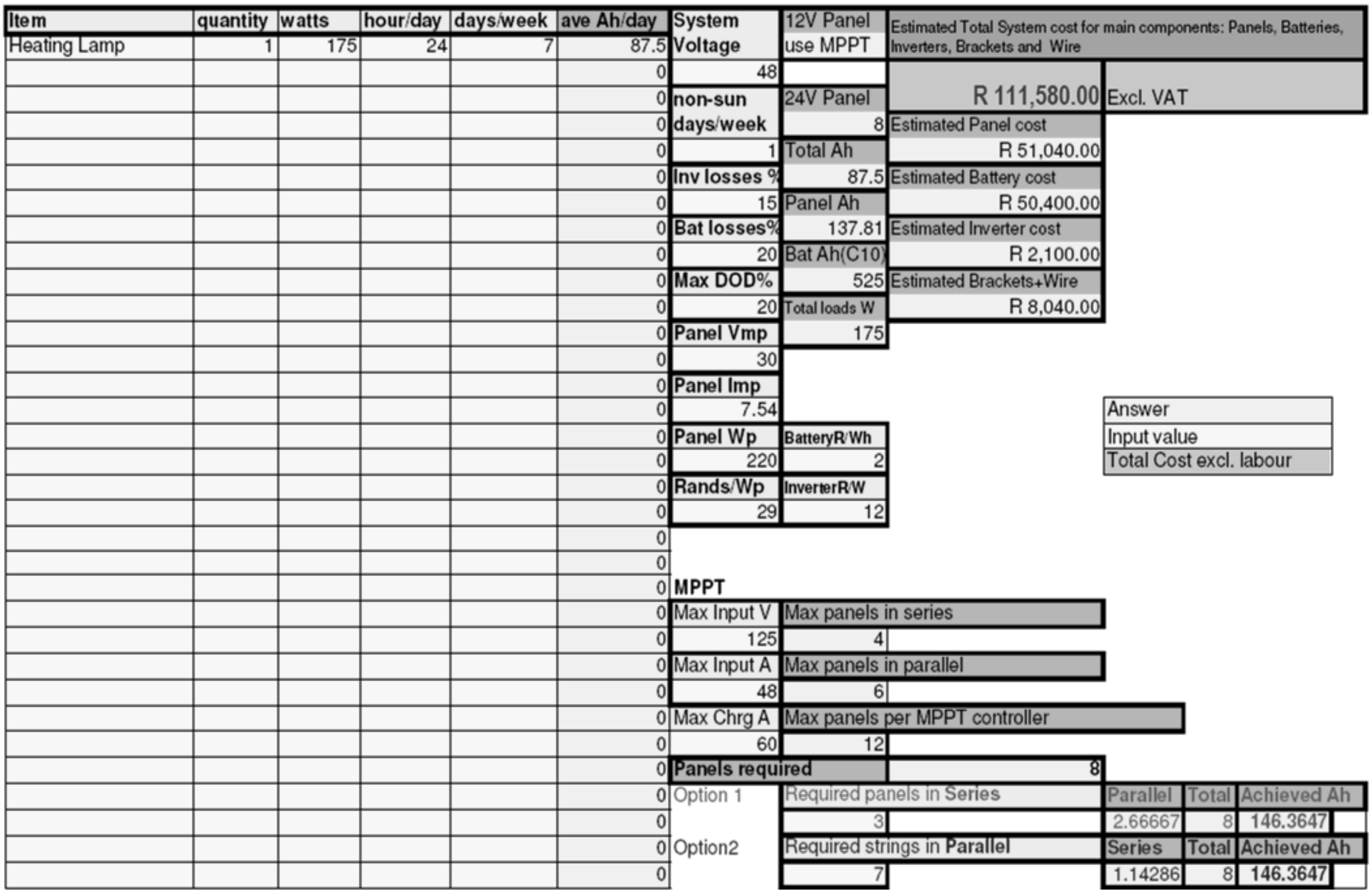
Solar panels:	20 to 25 years.
Batteries, regulators and inverters:	5 to 9 years.
Cabling and brackets:	2 to 5 years.

9.1.1. Sunflare

The quote was generated on 7 March 2011. All costs exclude VAT (Personal communication, Du Plessis, E., Sunflare, 7 March 2011).

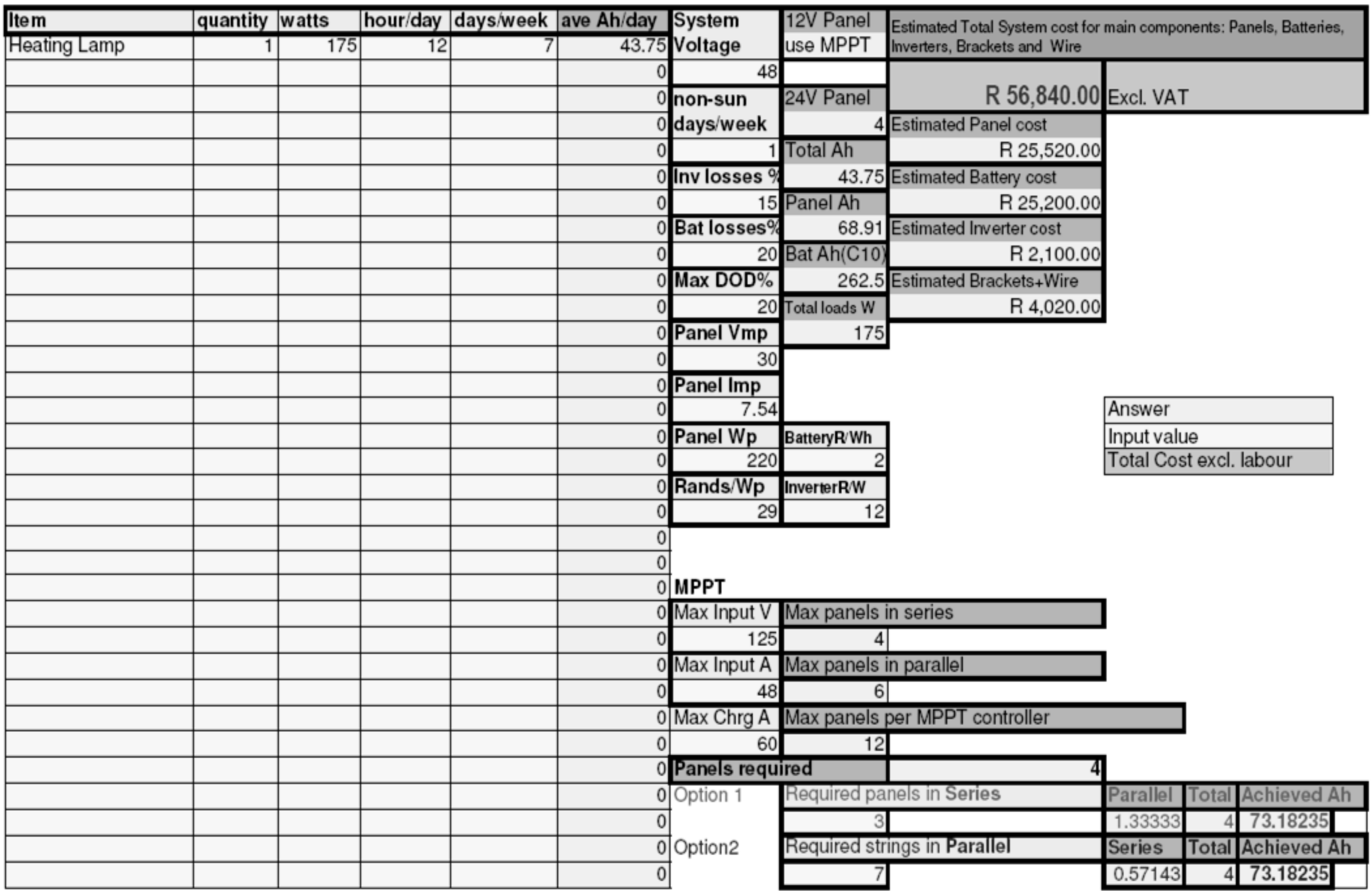
The high cost of the Sunflare system is attributed to their compensation calculation. The compensation calculation uses the average sun radiation per unit area of Europe, rather than the average for South Africa. The reason for this is that the Western Cape winter conditions are similar to the European climate. It is important to compensate for the worst possible lighting to ensure that the system will always function as intended (Personal communication, Du Plessis, E., Sunflare, 7 March 2011).

24 hour solar system:



Item	quantity	watts	hour/day	days/week	ave Ah/day	System	12V Panel	Estimated Total System cost for main components: Panels, Batteries, Inverters, Brackets and Wire			
Heating Lamp	1	175	24	7	87.5	Voltage	use MPPT				
					0	48					
					0	non-sun	24V Panel	R 111,580.00	Excl. VAT		
					0	days/week	8	Estimated Panel cost			
					0	1	Total Ah	R 51,040.00			
					0	Inv losses %	87.5	Estimated Battery cost			
					0	15	Panel Ah	R 50,400.00			
					0	Bat losses%	137.81	Estimated Inverter cost			
					0	20	Bat Ah(C10)	R 2,100.00			
					0	Max DOD%	525	Estimated Brackets+Wire			
					0	20	Total loads W	R 8,040.00			
					0	Panel Vmp	175				
					0	30					
					0	Panel Imp					
					0	7.54			Answer		
					0	Panel Wp	BatteryR/Wh		Input value		
					0	220	2		Total Cost excl. labour		
					0	Rands/Wp	InverterR/W				
					0	29	12				
					0						
					0						
					0	MPPT					
					0	Max Input V	Max panels in series				
					0	125	4				
					0	Max Input A	Max panels in parallel				
					0	48	6				
					0	Max Chrg A	Max panels per MPPT controller				
					0	60	12				
					0	Panels required		8			
					0	Option 1	Required panels in Series		Parallel	Total	Achieved Ah
					0		3		2.66667	8	146.3647
					0	Option2	Required strings in Parallel		Series	Total	Achieved Ah
					0		7		1.14286	8	146.3647

12 hour solar system:



Item	quantity	watts	hour/day	days/week	ave Ah/day	System	12V Panel	Estimated Total System cost for main components: Panels, Batteries, Inverters, Brackets and Wire				
Heating Lamp	1	175	12	7	43.75	Voltage	use MPPT					
					0	48		R 56,840.00	Excl. VAT			
					0	non-sun	24V Panel					
					0	days/week	4	Estimated Panel cost				
					0	1	Total Ah	R 25,520.00				
					0	Inv losses %	43.75	Estimated Battery cost				
					0	15	Panel Ah	R 25,200.00				
					0	Bat losses%	68.91	Estimated Inverter cost				
					0	20	Bat Ah(C10)	R 2,100.00				
					0	Max DOD%	262.5	Estimated Brackets+Wire				
					0	20	Total loads W	R 4,020.00				
					0	Panel Vmp	175					
					0	30						
					0	Panel Imp						
					0	7.54			Answer			
					0	Panel Wp	BatteryR/Wh		Input value			
					0	220	2		Total Cost excl. labour			
					0	Rands/Wp	InverterR/W					
					0	29	12					
					0							
					0							
					0	MPPT						
					0	Max Input V	Max panels in series					
					0	125	4					
					0	Max Input A	Max panels in parallel					
					0	48	6					
					0	Max Chrg A	Max panels per MPPT controller					
					0	60	12					
					0	Panels required		4				
					0	Option 1	Required panels in Series		Parallel	Total	Achieved Ah	
					0		3		1.33333	4	73.18235	
					0	Option2	Required strings in Parallel		Series	Total	Achieved Ah	
					0		7		0.57143	4	73.18235	

9.1.2. Sustainable.co.za

The quote was generated on 8 March 2011. Installation costs are R3500 per day. All costs exclude VAT (Personal communication, Lee-Wright, A., Sustainable.co.za, 08 March 2011).

24 hour solar system:

5 kWh systems (the size of this system takes sunless days into account).

5 x Tenesol Solar Module: TE 2000-200W: Solar panel @ R6 000.00 each	R 30 000
8 x Excis Batteries: SMF100 - 102Ah: Solar storage batteries @ R1 479.00 each	R 11 832
1 x Omnipower: HT-E-1500 Modified Sinewave inverter: Solar inverter	R 4 015
1 x Microcare: MPPT 40 Amp: Solar charge controller	R 3 986
System accessories	R 5 915
Total:	**R 55 748**

12 hour solar system:

3 kWh systems (the size of this system takes sunless days into account).

5 x Tenesol: Solar Module TE 1300-125W: Solar Panel @ R3750.00 each	R 18 750
6 x Excis Batteries: SMF100 - 102Ah: Solar Storage Batteries @ R1479.00 each	R 8 874
1 x Omnipower: HT-P-1200-24 Modified Sinewave Inverter with LED Bar: Solar Inverter	R 3 245
1 x Steca: PRS3030: Solar Charge Controller	R 1 303
System accessories	R 4 500
Total:	**R 36 672**

9.1.3. Sinetech

The quote was generated on 3 March 2011. The quote reference number is SK101681. All costs exclude VAT (Personal communication, Hüllermeier, K., Sinetech, 3 March 2011).

24 hour solar system:

The total load for 24 hours with losses included = 5.2 kW/hours.

4 x Solar panels	@	R 5332 each
1 x Inverter	@	R 330
1 x Regulator	@	R 880
12 x Deep cycle batteries	@	R 1137 each
Total:		R 36 182
Total (including cabling and brackets):		**R 48 242**

12 hour solar system:

Your total load for 12 hours with losses included = 2.6 kW/hours.

2 x Solar panels	@	R 5 332 each
1 x Inverter	@	R 330
1 x Regulator	@	R 756
6 x Deep cycle batteries	@	R 1 137 each
Total:		R 18 572
Total (including cabling and brackets):		**R 24 762**

9.2. Empolweni community questionnaire

Name: ____

Date: ____

This questionnaire is intended for those who currently farm with **5 or more** producing sows.

Guidelines to answering the questions:

- The questions refer to your current farm operations and not to how you would like it to be.
- Answer the questions to the best of your ability, even if your answer is just an approximation or an educated guess.
- Please circle the question number of the questions you don't understand or unwilling to answer.
- Please make an "X" at all the relevant tick boxes ☐. More than one box can be ticked per question.
- If you have any extra comments regarding the questions – please write it on the back of the question's page.

BACKGROUND

1. **Why are you farming with pigs?**
   - ☐ To feed your family with the pigs you raise.
   - ☐ It is your only income.
   - ☐ To add to your other incomes.
   - ☐ The pigs were given to you? Or you already had pigs.
   - ☐ Funding was given to farm with pigs.
   - ☐ You enjoy farming with pigs.
   - ☐ Other reason(s): ______________________________________
2. **How many years have you farmed at your current farm? ______________ Years**
3. **How many years in total have you farmed with pigs? ______________ Years**
4. **How many producing sows did you have from 2009 to 2010? ______________ Sows**
5. **How many producing sows did you have from 2010 to today? ______________ Sows**
6. **How many boars did you have from 2009 to 2010? ______________ Boars**
7. **How many boars did you have from 2010 to today? ______________ Boars**

8. Are you planning to:

☐ Continue as is.

☐ Expand your herd.

☐ To stop farming with pigs and sell off the rest of your pigs.

Why? ____

9. What is keeping you from expanding?

☐ There is not enough viable labour available or you do not have enough time.

☐ There is not enough water available for a bigger herd.

☐ Your current feed supplier will not have enough feed available.

☐ There is not enough demand (sales) for your pigs.

☐ You cannot afford to expand.

☐ You do not have enough pig farming expertise.

☐ You are content with your current farm size.

☐ Other reason(s)? ____

10. Do or did you receive any support from organisations, municipalities, universities and vets in the form of free or reduced fees for the following or any other services:

☐ Funding to start or support your farm.

☐ Free items (feed, building materials, etc.)

☐ Any kind of training

☐ Keeping records of your production performance.

☐ Treating your pigs with medicine.

☐ Other:

____

____

11. Do you have access to electricity? ☐Yes,☐No

LABOUR

1. How do you manage your farm:

☐ You manage it full time or part-time, which? ________________________________

☐ You have a labourer that manages your farm for you.

☐ You do all the farm work.

☐ Other: ____

2. **How many labourers do you currently employ? ____________________________ People**
3. **Are they part-time or full-time labourers? ____**
4. **How many labourers are working on the pig farm at a time? ________________________**
5. **Do their responsibilities include any non-pig farm activities? _______________________**
6. **Do you clean:**

   ☐ Outside your pig housing (such as removing debris and filth build-up).

   ☐ Inside the pens (such as waste removal).

   ☐ Disinfect the pen when the litter is removed.

   ☐ Other:

   ____

   ____

7. **How often do you clean? ____**

   ____

8. **What do you do with the collected manure after cleaning?**

   ☐ Make compost and sell it or use it for your own plants or crops? Sell or use? __________

   ☐ Dump it off-site.

   ☐ You never remove the manure.

   ☐ Other: ____

HOUSING

1. What is the size of the pens or cages for each of the following? **(m^2 or the lengths of the sides)**

   Sow(s):_________ m^2 per sow or ______ m by _____ m for a group of _____ sows.

   Boar:___________ m^2 per boar or _____ m by _____ m per boar.

   Litter:___________ m^2 per litter or _____ m by _____ m per litter.

   Extra comments on the size of the pens:

   ____

   ____

   ____

2. How do you compensate for the growth of the pigs?:

☐ You keep the litter in the same pen until you sell them.

☐ You make the pen bigger as the litter grows larger.

☐ You move the litter to a bigger pen as they grow larger.

☐ You put different litters together in a bigger pen.

☐ Other:

____

____

3. Do you use bedding? What do you use? For all or only specific types of pigs?

____

____

EQUIPMENT

1. What type of tools or equipment do you use on your farm? State next to the question whether you own, share (with other farms), borrow or rent the equipment?

☐ Transport vehicles, such as Bakkies and / or trailers __________________________________

☐ Maintenance tools, such as hammers and screw drivers ______________________________

☐ Cleaning tools, such as shovels, buckets, brooms, wheelbarrows _______________________

☐ Other:

____

____

BREEDING & FARROWING

1. Do you only use your own boar(s) for breeding or do you sometimes borrow other farmers' boars? ____

2. How do you replace old or infertile sows or boars?

☐ You buy new boars or sows? Only sows, only boars or both? __________________________

☐ You replace them from your own litters? Only sows, only boars or both? __________________

☐ Other: ____

3. How do you plan the breeding and subsequent farrowing?

☐ The sow is used for breeding as soon as she is ready after weaning.

☐ All the sows are serviced at the same time.

☐ Groups of ___ sows are serviced at the same time. ________________________________

☐ It depends on the season: ____

☐ Other: ____

5. Do you use any of the following equipment during farrowing:

☐ Crushing-prevention rails (Bars that prevent the sow from lying on the piglets).

☐ A creep area (A boxed-off part of the pen that is inaccessible to the sow).

☐ Heating for piglets, such as gas burners, fires or hot water bags.

☐ Farrowing crates (a halter or cage around the sow to limit her movement and for easier handling).

☐ Other:

____

____

➢ **For any other comments about the breeding & farrowing stage, write it on the back of this page.**

WEANING & GROWING

1. How do you decide when to wean? For example: You choose a specific age, a specific weight or does it differ greatly between litters?

____

____

➢ **For any other comments about the weaning & growing stage, write it on the back of this page.**

FEEDING

Answer the following three questions together on the lines below. The three questions are related to each other.

- **Feed type: What do you feed your pigs during each of their life stages? Such as:**
    - Bran, specific types of fruit or vegetables and meat products.
- **From: Where do you get each of these feed types? Such as:**
    - You or fellow farmers grow or buy the produce.
    - Buy it as a commercial (packaged) product from specific stores.
    - Get it for free from factories, stores and organisations.
- **Preparation: How do you prepare the feed before feeding it to your pigs? If you mix it, in what proportion is it done? Such as:**
    - Give it as is or you mix it with other feed or water.

For example:

Feed type: Bran and grower mix for piglets. **From:** Bran from nearest Fruit and Veg, grower mix from nearest Agrimark. **Preparation:** They are fed in equal proportions of grower and bran.

Piglet:

____

____

Weaned pig:

____

____

Growing pig:

____

____

Pregnant sow:

____

____

Nursing sow:

____

____

Boar:

____

____

1. **What do you use as a feeding trough? Is it anchored?**

   ____

   ____
2. **How often do you clean the feeding trough?** __________________________________
3. **Do you give larger troughs or bowls as the pigs grow bigger?** ____________________
4. **How many times per day are they fed?** _______________________________________
5. **What do you use as a feed store on your farm?** _______________________________
6. **How many days of feed do you usually store (the maximum amount of days before you have to go buy new feed)?** ____

- **For any other comments about the feeding, write it on the back of this page.**

WATER

1. **How far from your pig farm is the main water tank?** __________________________ **km**
2. **What do you use as a water store on your farm?** _______________________________
3. **Approximately how much water can you store?** ___________________________ **litres**
4. **What do you use as a water trough? Is it anchored?** __________________________

   ____
5. **How often do you clean the water trough?** ____________________________________
6. **Do you give larger water troughs or bowls as the pigs grow bigger?** _______________
7. **How many times per day do you give water to your pigs?** ________________________

MEDICATION

1. **Do you use medication (mineral and vitamin supplements and vaccinations)? If yes, do you, a vet or both administer it to the pigs?** ___________________________________
2. **What is the vet's name that you usually use?** ___________________________________
3. **What type of medication do you or your vet give to your pigs during each of the following stages?**

Piglet:

____

____

Weaned pig:

____

____

Growing pig:

____

____

Pregnant sow:

____

____

Nursing sow:

____

____

Boar:

____

____

4. **How do do you store your pig's medicine? Do you have cold storage?** ________________

   ____

➢ **For any other comments about medication, write it on the back of this page.**

INCOME/SALES

1. **Do you keep formal records of your sales?** ________________________
2. **You <u>usually</u> sell your pigs:**

☐ Before weaning, at the age of ______________________________ **days**

☐ After weaning, at the age of ______________________________ **days**

☐ At a specific weight, ______________________________ **kg**

☐ According to demand (you sell pigs of all ages, whether they are piglets or full grown)

☐ Other: ____

____

3. **What average price did you receive for the sale of each type of pig for the past year? Try to give an approximate age or weight, price received and how many of each you sold in2009 and 2010.**

- **<u>Piglets</u> - 2009:** ______________________________________

  ____
- **2010 to today:** ______________________________________
- **<u>Weaned and growing pigs</u> - 2009:**______________________________

  ____
- **2010 to today:** ______________________________________
- **<u>Sows</u> - 2009:** ______________________________________

  2010 to today:______________________________________

- **Boars - 2009: ____**

  2010 to today:____

4. Average income from pig sales in 2009? R _________________________________

5. Average income from pig sales for this year? R ____________________________

6. How many pigs per year do you use for something other than sales?

☐ **Using pigs from a litter for breeding stock – how many sows and/or boars?: _________**

☐ **Own use or give it away: ____**

☐ **Other: ____**

7. Do you receive any other income, besides pig sales, from your pig farm, such as selling the manure/compost? ____

____

8. Do you ever deliver the pigs to the customer or do they always come pick it up?

____

9. From where are your customers? _____________________________________

____

____

10. What time of the year do you usually sell pigs? Is there a stable demand for your pigs?

____

____

11. Does your income compensate for your living expenses as well as your farming expenses?

____

____

12. Your customers usually:

☐ Visits your farm and then buy the type of pigs that are available / those they want.

☐ They tell you what they want and then you contact them when you have those types of pigs available.

☐ Other:

____

____

➢ **If you have any other comments about income, write it on the back of this page.**

EXPENSES

1. Do you keep formal records of your expenses? ______________________________________

2. Approximately how much did you spend on each of the following for 2009 and 2010 until today?:

- <u>Each type of feed:</u> 2009: ____
  ____
  ____
  2010 to today: ____
  ____
  ____
- <u>Buying new breeding stock (sows or boars):</u> 2009: ______________________
  2010 to today: ____
- <u>Fuel and transport (to buy supplies):</u> 2009: ______________________
  2010 to today: ____
- <u>Labour:</u> 2009: ____
  2010 to today: ____
- <u>Equipment:</u> 2009: ____
  2010 to today: ____
- <u>Cleaning supplies and disinfectants:</u> 2009: ______________________
  2010 to today: ____
- <u>Maintenance of your pig housing (Materials):</u> 2009: ______________________
  2010 to today: ____
- <u>Medication:</u> 2009: ____
  2010 to today: ____
- <u>Veterinary fees:</u> 2009: ____
  2010 to today: ____
- <u>Bedding:</u> 2009: ____
  2010 to today: ____

➢ <u>Other:</u> 2009: ____
____
2010 to today: ____
____

Did you buy any items (such as feed or materials) in bulk at a discounted price?
____
____

3. Are you receiving any of the following for free?

- Feed:
  ____
  ____

- **Housing materials:** ____

  ____

- **Water:** ____

  ____

- **The land:** ____

  ____

- **Other:** ____

  ____

➢ **If you have any other comments about expenses, write it on the back of this page.**

PRODUCTION

1. **Do you keep formal production records, such as:** Litters per year, litter size**,** mortalities and pigs weaned per litter?

   ____

   ____

2. **How many litters were born in 2009?** ______________________________
3. **How many litters were born from 2010 to today** ______________________________
4. **Average number of piglets born per litter:** ______________________________
5. **Average number of piglets weaned per litter:** ______________________________
6. **Average number of stillborn piglets per litter:** ______________________________
7. **Average mortalities per litter before weaning:** ______________________________
8. **Average mortalities per litter after weaning:** ______________________________
9. **What do you consider the biggest reason(s) for the deaths? Use the lines if you have additional comments.**

☐ Disease: ____

☐ Hypothermia (cold): ____

☐ Heat stroke: ____

☐ Overlying: ____

☐ Other: ____

10. **How many of your producing sows died in 2009?** ______________________________

    Possible reasons: ____

    ____

11. **Number of miscarriages/abortions in 2009:** ______________________________
12. **Number of your sows that become infertile (incapable of conceiving) in 2009:** _________

13. **How many of your breeding boars died in 2009?** ____________________________

    Possible reasons: ____

    ____

14. **Number of your boars that become infertile in 2009:** _____________________

RISKS

1. **How common is diseases in your herd? What type of pigs is affected? If you don't know the name of the disease just name the symptoms, such as diarrhoea or a loss of appetite.**

   Piglets:

   ____

   ____

   Weaned and growing pigs: ____

   ____

   Sows: ____

   ____

   Boars: ____

   ____

2. **What do you do with sick pigs?**

☐ Remove them to separate housing.

☐ Cull/kill them.

☐ Leave them in their pen and / or with their litter.

☐ Other: ____

3. **Do your pigs get stolen? How often does this happen? When did it last happen?** _____

   ____

4. **Do your pigs ever escape and run away? How often does this happen? When did it last happen?** ____

5. **Do you have problems with animals (dogs, cats, wild animals) attacking your pigs? How often does this happen? When did it last happen?** ___________________

   ____

6. Are your pigs ever exposed to any of the following weather conditions? You can comment on each type of occurrence on line next to the condition:

☐ Strong winds or drafts: ____

☐ Heavy rain: ____

☐ Direct sunlight: ____

☐ Too cold: ____

☐ Too warm: ____

☐ Too humid: ____

☐ Other: ____

7. Do you consider that your pigs have adequate protection (trees and constructed shelter) from these weather conditions? ________________________________

____

8. Have you experienced long periods where there was no demand for your pigs? How long? ____

9. What do you consider the biggest problem or risk to your pig farm business? ______

____

10. Do you have any other problems or risks on the pig farm? ___________________

____

***** THANK YOU *****

9.3. Casidra pig housing cost estimate

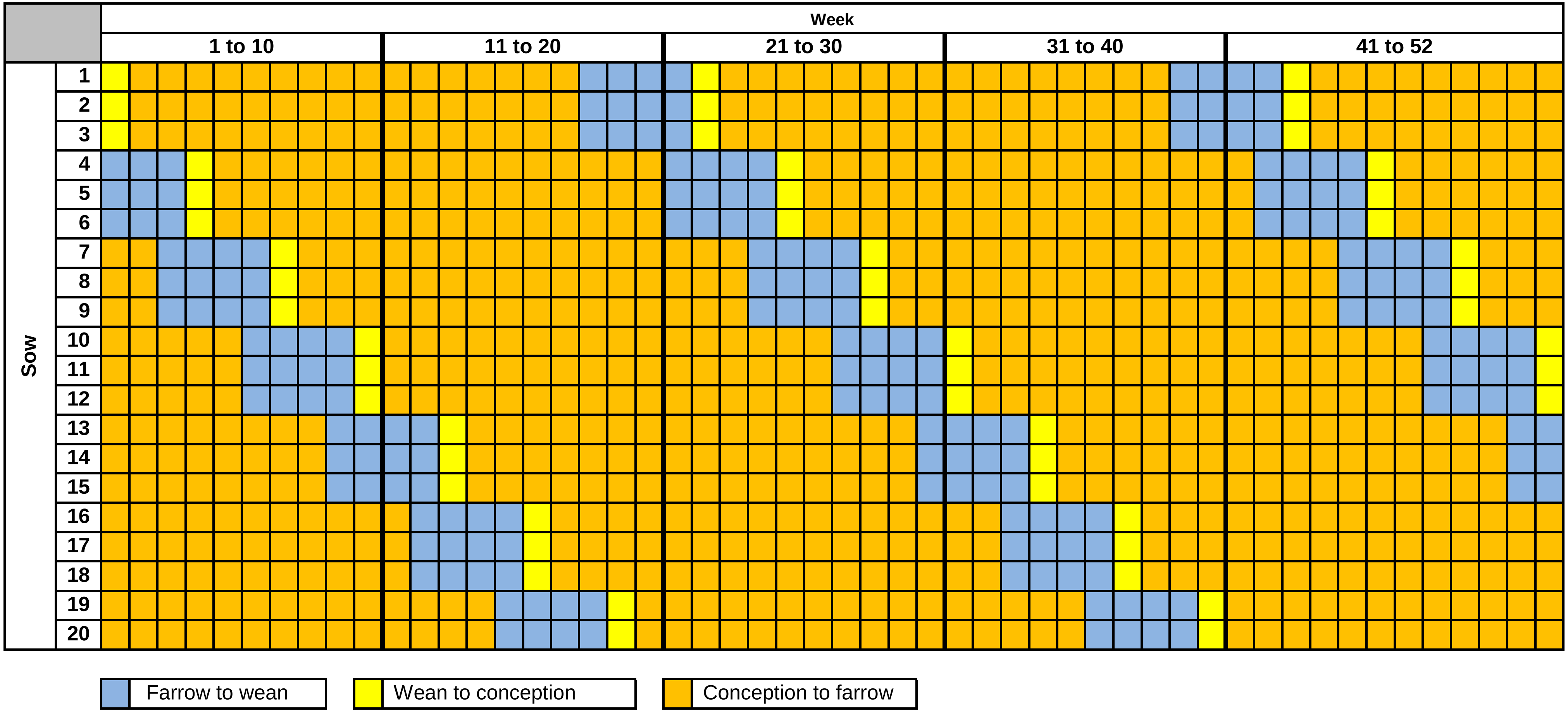
Table 9.2 shows a breakdown of Casidra's estimated housing, infrastructure and equipment costs for 5 sow, 10 sow, 15 sow and 20 sow pig farms. The design includes a feed storage area in a closed-off room.

Table 9.2 Estimated cost for Casidra pig housing, infrastructure and equipment

	Unit size (Sows)			
	5	**10**	**15**	**20**
Earthworks	R 9 360	R 18 720	R 28 080	R 37 440
Concrete bases to wooden poles	R 2 466	R 4 933	R 7 399	R 9 866
Mass concrete footings to walls	R 11 237	R 22 475	R 33 712	R 44 949
Concrete floor	R 8 084	R 16 167	R 24 251	R 32 335
Brick walls	R 19 510	R 39 019	R 58 529	R 78 039
Roof (including poles)	R 42 725	R 85 451	R 128 176	R 170 902
Loading bay	R 25 000	R 25 000	R 25 000	R 25 000
Barber flycatcher*	R 16 000	R 16 000	R 16 000	R 16 000
Water tank (5 000 litres)	R 7 000	R 7 000	R 7 000	R 7 000
Plumbing work	R 15 000	R 18 500	R 22 000	R 25 500
Tank stand	R 12 000	R 12 000	R 12 000	R 12 000
Septic tank	R 9 500	R 9 500	R 9 500	R 9 500
French drain	R 6 000	R 6 000	R 6 000	R 6 000
Fencing (internal)	R 12 950	R 25 900	R 38 850	R 51 800
Fencing security	R 46 800	R 65 000	R 74 100	R 83 200
Gates opening (900 mm)	R 9 000	R 18 000	R 27 000	R 36 000
Precast toilet	R 8 000	R 8 000	R 8 000	R 8 000
Drainage system	R 28 000	R 28 000	R 28 000	R 28 000
Wendy house (6 x 3 m)	R 10 000	R 10 000	R 10 000	R 10 000
Total	R 298 633	R 435 665	R 563 598	R 691 530
Value-added Tax	R 41 809	R 60 993	R 78 903.65	R 96 814
Grand Total	**R 340 441**	**R 496 658**	**R 642 501**	**R 788 344**
Cost per sow	**R 68 082**	**R 49 666**	**R 42 833**	**R 39 417**

Source: Personal communication, A. Otto, Casidra Project coordinator: Technical (Paarl), 31 October 2011

9.4. Batch farrowing system



		Week																																																		
		1 to 10										11 to 20										21 to 30										31 to 40										41 to 52											
Sow	1	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧
	2	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧
	3	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧
	4	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧
	5	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧
	6	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧
	7	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧
	8	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧
	9	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧
	10	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨
	11	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨
	12	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨
	13	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦
	14	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦
	15	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦
	16	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧
	17	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧
	18	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧
	19	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧
	20	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧

🟦 Farrow to wean
🟨 Wean to conception
🟧 Conception to farrow

Figure 9.1 **Smallholder commercial pig farm three week batch farrowing system**

9.5. Evaluation equations overview

The calculations in this section are kept on a generic level to compensate for different production performance levels. Refer to Table 5.1 for the production performance input parameters.

9.5.1. Start-up costs

Start-up costs
= Housing, infrastructure and equipment + Breeding stock + First year production costs

9.5.2. Income

Estimated annual income from slaughter pigs
= Slaughter pigs (#) x Carcass weight (kg) x Price received (R/kg)

Estimated annual income from culled pigs
= Culled pigs (#) x Carcass weight (kg) x Price received (R/kg)

Total annual income
= Slaughter pig income + Culled pig income

9.5.3. Production costs

Feed costs

Table 9.3 shows the base model's (Scenario 2) feed costs calculation. The "Days" column is adjusted for Scenarios 1, 3 and 4 by the required percentage to reflect the specific scenario's growth rate on Table 5.1. Similarly, the "Total feed per pig (kg)" is adjusted to reflect the specific scenario's FCR.

Table 9.3 Base model feed costs calculation

Production stage	Days	Feed per day (kg)	Feed per pig (kg)	Feed waste (kg)	Herd size	Total feed (kg)	Cost per kg	Cost per production stage
Piglets	14	0	0.00	0.00	409.40	0.00	R 0.00	R 0
Piglets	14	0.06	0.81	0.03	409.40	344.21	R 6.33	R 2 177
Weaners	9	0.96	8.66	0.35	409.40	3 687.97	R 6.33	R 23 331
Weaners	32	0.96	30.80	1.23	409.40	13 112.78	R 3.74	R 49 094
Growers	7	1.54	10.78	0.43	386.86	4 336.80	R 3.74	R 16 236
Growers	29	1.54	44.66	1.79	386.86	17 966.72	R 3.36	R 60 368
Growers	15	1.54	23.10	0.92	386.86	9 293.13	R 3.30	R 30 689
Finishers	12	2.50	30.03	1.20	386.86	12 081.07	R 3.30	R 39 896
Finishers	36	2.50	90.08	3.60	386.86	36 243.22	R 2.96	R 107 163
Boar	365	2.30	839.50	33.58	1.00	873.08	R 3.02	R 2 640
Dry sow	283	2.30	650.90	26.04	20.00	13 538.72	R 3.02	R 40 941
Lactating sow	17	2.30	39.10	1.56	20.00	813.20	R 3.37	R 2 740
Lactating sow	65	7.00	455.00	18.20	20.00	9 464.00	R 3.37	R 31 889
Replacement boar	132	2.30	303.60	12.14	0.33	105.25	R 3.02	R 318
Total						**121 860**		**R 407 488**

***** The 4% current to annual average conversion adjustment (Section 2.3.3) is included in the feed costs.

Living costs

Annual living costs
= Monthly income x 12

Veterinary supplies costs

Sows' annual vaccination costs
= (Farrowsure container cost + Scourmune container cost) x Farrowing groups x Litters per sow per year

Piglets' annual vaccination and injection costs
= M+Pac container cost x Containers x Farrowing groups x Litters per sow per year + Sows x Live born piglets per litter x Litters per sow per year x Ferdex container cost / injections

Additional veterinary supplies
= Sows (#) x Additional veterinary supplies per sow

Total annual veterinary supplies costs
= Sows' annual vaccination costs + Piglets' annual vaccination and injection costs + Additional veterinary supplies

Replacement sows costs

Replacement sows costs
= Sows (#) x Cost per sow

Utility costs

Electricity costs per year
= [Heating lamp wattage (kW) x Daily heating hours (h) x Heating period (days) x Electricity cost (R/kW) / Efficiency (%)] x Sows (#) x Litters per sow per year

Total monthly water cost
= Monthly fresh water cost + Monthly sanitation cost

Total annual utility costs
= Electricity costs + Water costs

Maintenance, repairs and replacements

Heading lamps required per year

= Sows (#) x Litters per sow per year x Daily heating hours (h) x Heating period (days) / Lifetime (h)

Maintenance, repairs and replacements

= Maintenance cost per year + Heating lamps required per year x Cost per heating lamp

Transport costs

Transport total vehicle operating cost

= [Fixed cost (R/km) x 60 km + Running cost (fully loaded & trailer adjustment) x 30 km + Running cost (trailer adjustment) x 30 km] x Sows (#) x Litters per sow per year

Diverse costs

Diverse costs

= Sows (#) x Cost per sow per year

Artificial insemination costs

Artificial insemination costs

= Sows (#) x Litters per sow per year x AI costs per farrowing

Labour costs

Labour costs

= Sows (#) x Labour cost per sow

Estimated annual production costs

Estimated annual production costs

= Feed costs + Living costs + Veterinary supplies costs + Replacement sows costs + Utility costs + Maintenance, repairs and replacements + Transport costs + Diverse costs + Artificial insemination costs + Labour costs

9.5.4. Results

Estimated annual profit / loss

= Estimated annual income - Estimated annual production costs

ROI calculation

= (Annual profit [or loss] / Annual production costs) %

Feed conversion ratio

= (Feed required per slaughter pig + Feed wastage compensation) / Live weight at slaughter