Chapter 8

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1 SUMMARY

During the literature study it became evident that there is ample literature available on crop technology transfer and adoption, but that research done on livestock technology transfer and adoption is rather scarce. To overcome this barrier it was decided to construct a panel of livestock veterinary specialists, consisting of veterinarians, animal scientists and extension officers (some from former Qwaqwa), to assist with the defining of the different categories of adoption and also the identification of variables that may contribute to the adoption of livestock veterinary technologies.

In this study possible predictors for the adoption of livestock veterinary technologies were identified by means of presenting significant differences (p-values $\leq 0{,}15$) between the various adoption groups and then fitted into logit models. Seven logit models were fitted for the different adoption groups of veterinary surgeon services, external and internal parasite remedies, antibiotics and vaccine technologies and an additional multinomial logit model was fitted for internal parasite remedies, using the predictors of the previous logit models for internal parasite remedies as possible predictors. The results of the multinomial logit model were similar to those of the two logit models. Only the results of the logit model will therefore be discussed.

A summary of the significant variables of each of the seven logit models (two for veterinary surgeon services and five for the four medication groups) with their respective parameters and chi-square values, are presented in Table 8.1. The significant variables of each adoption model with their respective coefficients and chi-square values are also presented. All 14 **continuous variables** initially considered were included as possible predictors in one or more of the seven different logit models. Of these, eight were retained in one or more of the logit models as predictors (p-values $\leq 0{,}15$) contributing to the different adoption categories. From these eight continuous predictors only one (type of farmer) appears in three different logit models, two predictors (age and livestock income per livestock unit [LSU]) appear in two logit models, and the rest (family size, farming efficiency, herd size, mortality rate and purpose of farming) were significant predictors in only one logit model of adoption.

Of the 20 **categorical variables** initially considered, 13 were included as possible predictors in one or more of the seven different logit models fitted. Of the 13 possible predictors of adoption, 12 were retained in one or more logit models as predictors (p-values $\leq 0{,}15$) contributing to the different adoption categories. One categorical variable (risk-averse) appears in three different logit models, four variables (financial management, roads, suppliers of inputs/outputs and breeding technology) were significant predictors in two logit models and the rest (technical information [co-farmers], technical information [extension sources], financial information [co-farmers, extension sources], transport, local markets and mating seasons) were only significant predictors for one logit model of adoption.

The high percentage of variables retained in the logit models as predictors for adoption, indicates a good overall selection of possible predictors. As can be seen in the seven different prediction models for adoption of livestock veterinary technologies, there are considerable differences with regard to the significant predictors. This is a clear indication that the separation of livestock veterinary technologies in veterinary surgeon services and in four different types of medication technology (external parasite remedies, internal parasite remedies, antibiotics and vaccines) was necessary and sensibly done.

Table 8.1: **SUMMARY OF LOGIT MODEL RESULTS ON THE ADOPTION OF VETERINARY SURGEON SERVICES AND MEDICATION TECHNOLOGIES**

VARIABLES	Veterinary surgeon services				External parasite remedies		Internal parasite remedies				Antibiotics		Vaccines	
	A vs Po/A & N/A		A & Po/A vs NA		F&O/A vs P/A		F/A vs P/A		O/A vs P/A		P/A vs N/A		P/A vs N/A	
	Parameter	P>Chi*	Parameter	P>Chi*	Parameter	P>Chi*	Parameter	P>Chi*	Parameter	P>Chi*	Parameter	P>Chi*	Parameter	P>Chi*
CONTINUOUS VARIABLES														
Age					-0,059	0,087	0,088	0,028						
Family size											0,343	0,026		
Farming efficiency			0,036	0,026										
Total livestock income per LSU per year	0,003	0,0002							0,002	0,079				
Herd size													0,011	0,102
Mortality rate in 1997											1,910	0,078		
Purpose of farming									-0,405	0,126				
Type of farmer			0,017	0,073			0,038	0,055					0,024	0,007
CATEGORICAL VARIABLES														
Risk D2 – risk-averse					-1,192	0,143	-2,286	0,051	-2,010	0,071				
Financial management							1,090	0,138	1,309	0,148				
Information – Technical decisions d2 (co-farmers)					2,323	0,142								
Information – Technical decisions d3 (extension sources)					3,529	0,013								
Information – Financial decisions d2 (co-farmers)											-2,097	0,050		
Information – Financial decisions d3 (extension sources)													1,176	0,090
Infrastructure:														
Roads	1,504	0,0038									1,349	0,127		
Transport													-1,687	0,015
Local markets					-0,677	0,024								
Suppliers of inputs/outputs	2,243	0,0004							-2,088	0,067				
Mating seasons					1,611	0,039								
Breeding technology	1,496	0,0101	1,528	0,040										

* p<0,01 = Highly significant p<0,05 = Significant p<0,15 = Relatively significant

A = Adopters; Pot/A = Potential adopters; P/A = Partial adopters; F/A = Full adopters; O/A = Over-adopters; N/A = Non-adopters

The summary of the frequency analysis of the **adoption of medication technology** indicated that none of the 99 farmers were full adopters for all the medication groups simultaneously (external and internal parasite remedies, antibiotics and vaccines). Only 30 per cent of the farmers fully adopted internal and external parasite remedies and partially adopted antibiotics and vaccines. When internal and external parasite remedies are considered, only eight per cent of the farmers fully adopted both technologies, *versus* a 12 per cent partial adoption and nine per cent over-adoption of both medications. On the other hand, only one per cent of the farmers (one farmer) was a non-adopter of internal parasite remedies, antibiotics and vaccines, but was, however, a full adopter of external parasite remedies. This is a further indication that farmers in Qwaqwa are aware of the importance of medication technologies, but that the incorrect usage thereof still poses a problem that needs urgent attention.

If the frequency of adoption of the **veterinary surgeon services** is summarised with the adoption of medication technology, the scenario aggravates to some extent. Of the 99 farmers, only 20 per cent were adopters of veterinary surgeon services as well as full adopters of external parasite remedies and partial adopters of internal parasite remedies, antibiotics and vaccines. Only seven per cent of the farmers were potential adopters of veterinary surgeon services as well as full adopters of external parasite remedies and partial adopters of internal parasite remedies, antibiotics and vaccines.

In Table 8.1 potential adopters of veterinary surgeon services were identified and defined as farmers who would have adopted veterinary surgeon services had it been available and accessible. Thirty-five per cent of the farmers were potential adopters of veterinary surgeon services. Two logit models were fitted; in the first model the potential adopters were grouped with the non-adopters and in the second model the potential adopters were treated as adopters. The results of the two models indicate that the characteristics of the potential adopters gravitate more to those of the adopters than those of the non-adopters.

Some of the continuous variables retained in one or more logistic models as predictors of adoption of livestock veterinary technologies showed interesting results that deserve mentioning. "**Age of farmer**", which appears in two different logistic models, once with a negative coefficient (external parasite remedies) and once with a positive coefficient

(internal parasite remedies), indicates that the younger small ruminant farmers tend to be less conservative and more likely to adopt external parasite remedies, but more conservative towards the use of internal parasite remedies. A possible reason for these contradictory results is that it is relatively more easy to identify (diagnose) external parasite infestations on animals (ticks and scab) and to apply external parasite remedies, than it is to diagnose internal parasite infestation and to apply internal parasite remedies. The correct adoption of internal parasite technologies requires more experience which only comes with time, i.e. age.

Breeding technology used was selected as a significant predictor in the two veterinary surgeon services models. This is an indication that the usage of registered or graded rams contributes to the enhancement of adoption of veterinary surgeon services technologies, and *vice versa*. This result is perhaps obvious because farmers with more expensive breeding stock will take better care of their animals and make more use of veterinary surgeon services. The use of **mating seasons** was a positive predictor for full and over-adoption of external parasite remedies. A high percentage of farmers (79% of full and over-adopters and 46% of partial adopters) were using mating seasons.

Both measurements of **farming efficiency**, **weaning percentage** (technical), and **livestock income per LSU** (financial), emerged as predictors of adoption of one or more livestock veterinary technologies (Table 8.1). Farming efficiency (weaning percentage) emerged as a contributor only to the adoption of veterinary surgeon services (adapted definition, where potential adopters are grouped with adopters). These two efficiency measurement variables (weaning percentage and total livestock income per LSU) can either be predictors for the adoption of veterinary surgeon services or a result of using them. Special care must therefore be taken when analysing and interpreting these variables. In this study these variables are used as predictors. Total livestock income per LSU per year presented positive coefficients in the veterinary surgeon services logit model (conventional definition of adoption) as well as in the internal parasite remedy logit model (over-adopters *versus* partial adopters). This is an indication that a higher livestock income per LSU per year contributes positively to the adoption of veterinary surgeon services and to over-adoption of internal parasite remedies relatively to partial adoption. So it can be generalised that higher financial efficiency contributes to the adoption of veterinary surgeon services and internal parasite remedies and *vice versa*.

Herd size presented interesting results in the sense that it was included as a possible predictor in three of the seven logit models (external, internal parasite remedies and vaccines), but it was only selected as a significant predictor contributing to the adoption of vaccine technology. **Transaction costs** (which in Qwaqwa are mainly transport costs) only play a significant role where farmers have to obtain vaccines. In circumstances where transaction costs form a substantial part of fixed costs, the larger herd sizes contribute to lower the fixed costs per animal unit, which in turn lowers the total costs of adopting new technologies. These results suggest that the fixed cost part of transaction costs on livestock technologies are not so important. This variable was not significant in the other medication models in which the adoption of therapeutic remedies was tested. In a communal grazing system, herd size would not have a major impact on the transmission of diseases and endo- and ecto-parasites as there are frequent contact between different herds. In the case of vaccination, however, the fact that vaccines are sold in large dosages per package and have a short life after being opened, may discourage smaller farmers from adopting vaccines for the treatment of only a few animals, considering that the rest of the vaccine will possibly be wasted.

Sheep, as a percentage of the total small ruminant herd, significantly contributed to the adoption of veterinary surgeon services (adapted definition), full adoption of internal parasite remedies as well as partial adoption of vaccines technology (Table 8.1). This is an indication that sheep farmers are more likely to be adopters of veterinary services and the two mentioned medication groups, than goat farmers, as sheep are more susceptible to internal parasites and diseases than goats.

The variable "**family size**" appeared only in the antibiotics logit model as a significant predictor contributing positively to the partial adoption of antibiotics. This indicates that larger families are more wealthy and thus more likely to adopt antibiotic technologies, probably because they may have more sources of income (spendable money) to buy such expensive medicines for their herds.

Even though the **mortality rates** reported by the local farmers are extremely low (<1,1%), it presented a significantly positive coefficient, which indicates that higher mortality rates will influence or motivate farmers to use antibiotics to lessen the mortality rate among their sick animals.

The negative coefficient of **purpose of farming** on the internal parasite remedies indicates that over-adopters of these remedies regard the keeping of small ruminants for normal commercial farming purposes (selling purposes) as less important than partial adopters. Most of the over-adopters keep animals as an investment or as capital invested that can easily be converted into cash. This manner of "saving" is also related to the need of the farmers to reduce their transaction costs for accessing their capital (withdrawing money). If these farmers have to travel to urban areas every time they need to withdraw money from banks, they would spend a large proportion of the money withdrawn on transport costs. By keeping small ruminants, farmers can easily convert them into cash at local markets, thus reducing the transaction costs involved in the operation.

The negative coefficient of **risk aversion** (Table 8.1), in both the external and internal parasite remedy models, indicates that farmers who are risk-averse are more likely to be only partial adopters, while those who are risk-seeking tend to be full and over-adopters of these two medication groups. This, however, does not mean that risk-averse farmers will not adopt these remedies, but only that they are more cautious when spending money on these medications. Farmers try to protect their profit flow by only applying these remedies when it is absolutely necessary.

The category "**infrastructure**" has three variables which to some extent has a significant influence on the adoption of three of the four groups of livestock veterinary technologies. **Roads** have a positive effect on the adoption of veterinary surgeon services and partial adoption of antibiotics, while **transport** contributes negatively to partial adoption of vaccines and **local markets** contribute negatively to full and over-adoption of internal parasite remedies. These results indicate that farmers with more access to transport and roads favour the adoption of therapeutic technologies to treat already sick animals, while farmers with less access to transport and roads are probably more forced to adopt preventative technology (prophylactic vaccination).

Transport has a negative coefficient in the vaccine logit model (Table 8.1), which indicates that higher availability and accessibility of transport contributes negatively to the adoption of vaccine technologies. This in practice indicates that farmers with access to transport may feel it is unnecessary to use prophylactic treatment on their animals because it would be easy for them to buy antibiotics or to take sick animals to the

veterinary surgeon. This hypothesis seems to be confirmed by the fact that roads as infrastructure contributed positively to the adoption of veterinary surgeon services (conventional definition of adoption) and also to partial adoption of antibiotics. This supports the hypothesis that livestock farmers react on what they see. Inverting this tendency can have far-reaching economic effects on the local small ruminant production system because prophylaxy (prevention) is economically more advantageous than therapy (treatment).

Extension visits did not emerge as a significant contributor to the adoption of livestock veterinary technologies, but technical decisions, using extension sources and co-farmers, indicate that farmers who are full and over-adopters of external parasite remedies and partial adopters of vaccines tend to make their technical and financial decisions by using extension sources and co-farmers as information source. These results further indicate that the present extension service might not be effective when it comes to transferring technical information on the usage of medication technology as farmers are not sufficiently visited by extension officers either on their farms or at the sheering sheds.

The better the availability and accessibility of **input suppliers, output markets and banking services**, the less likely it will be that farmers will be over-adopters relatively to partial adopters. This result implies that if more input suppliers and output markets were available and accessible, and if more advice and information on the use of internal parasite remedies can be provided to farmers, they will tend to use the expensive medication more efficiently and would not become over-adopters. This result is supported by the theory of Von Thünen, who stated that the cost of information becomes too expensive for farmers who are located further away from the sources due to increased transport cost, and that the cost and the quality of information have an influence on the level (correctness) of adoption of new technologies. If the efficiency of the extension services could be improved, and more information could be available to farmers, they will tend to more correctly adopt medication technologies.

8.2 CONCLUSIONS

The following conclusions can be drawn from the results discussed above:

8.2.1 GENERAL

- Population growth forced farmers in Old Qwaqwa to move to the mountainous areas, which are further away from the servicing points, resulting in an increase in transportation costs (transaction costs) for inputs and services.

- The absence of extension visits as a predictor of veterinary surgeon services and/or medication adoption may be an indication that extension services are not functional and efficient. Extension visits are a very important determinant of technology transfer and adoption in most of the existing studies, however it does not feature in any of the livestock veterinary technology adoption models in this study.

- Access to credit did not feature as a predictor of livestock veterinary technology adoption, as livestock production systems in Qwaqwa are not capital intensive and when small ruminant farmers are in need of money to buy inputs, they sell some of their stock. In fact, the level of indebtedness amongst the small ruminant farmers is very low.

- Sheep farmers are more likely to use veterinary surgeon services, internal parasite remedies and vaccines, as sheep are more susceptible to diseases and parasites than goats are.

- The variable "location of farmers (Old and New Qwaqwa)" did not emerge as a significant predictor contributing to adoption of any of the livestock technologies, which is against expectations. The data presented complete separation for the variable "Qwaqwa" in the antibiotics and vaccine models where all the non-adopters were from Old Qwaqwa. This result may be an indication that the variables identified by the theory of von Thünen has an influence on the adoption of these two medication technologies as farmers in Old Qwaqwa are situated further away from the input suppliers.

8.2.2 VETERINARY SURGEON SERVICES

- The suspension of veterinary services, provided by the government at the sheering sheds before 1994, contributed to an increase in the costs of these services, inputs and information. Together with the deterioration in infrastructure and institutions, this may have caused a collapse of the livestock veterinary technology transfer process in Qwaqwa.

- The major constraints of livestock veterinary technologies adoption in Qwaqwa are the flow and cost of information as well as the supply of inputs and services. The withdrawal of the subsidised veterinary and extension services from the servicing points (sheering sheds in Old Qwaqwa and farmer days in New Qwaqwa) have had a negative effect on the correct adoption of livestock veterinary technologies, as well as the profit of the small ruminant farmers as they now have to spend much more money, effort and time to attain services, inputs and information, at centres further away from the sheering sheds.

- The adapted definition for adoption of veterinary surgeon services presented a more accurate model of adoption prediction than the conventional definition, as under inelastic conditions of supply of this technology, the characteristics of potential adopters gravitate more to those of the adopters than to the non-adopters. When the assumption of elastic supply of services or inputs, and increased transportation costs due to the farmer's location is violated, potentially misleading conclusions can be made regarding the significance of variables (predictors) that contribute to the adoption of technologies based on the traditional definition of adoption. If this aspect is ignored by policy-makers, it can lead to inefficient policies on technology transfer and adoption, as it becomes very difficult to clearly interpret the cause/effect relationships between factors.

- Restricted access to roads, the difficult access to the input and output markets, services, information, financial efficiency and the high cost of veterinary services provided by a private veterinary surgeon, are major constraints to most of the potential adopters of the technology "veterinary surgeon services". The availability and usage (adoption) of registered and grade rams, farming efficiency and farming

with sheep are in turn contributors to the adoption (conventional definition) of veterinary surgeon services technology.

8.2.3 MEDICATION

- Grouping of medication technology is essential if research on the characteristics of farmers using these technologies have to be estimated. The importance of transport costs, the fact that former homeland farmers react on what they see when it comes to usage of medication technology, makes them more likely to adopt therapeutic (treatment) medication (external, internal remedies and antibiotics) rather than prophylactic (prevention) medication (vaccines), which is evident throughout this study.

- Diffusion programmes in Qwaqwa might have been more effectively done in the past as the veterinary surgeon, the extension and animal health officers have made small ruminant farmers aware of the importance and usage of the most important livestock veterinary technologies (veterinary surgeon services and medication). The absence of a continuous information flow at the sheering sheds (Old Qwaqwa) and farmer days (New Qwaqwa) could have resulted in a high occurrence of incorrect usage of three of the four medication groups (external, internal parasite remedies and vaccines).

- Partial adopters of external parasite remedies are more conservative, older, more risk-averse, do not use extension sources when making technical decisions, have better access to local markets and make less use of mating seasons.

- The usage of internal parasite remedies, which might have been transferred more efficiently before 1994, shows a severe lack of basic knowledge of farmers on the correct application of these drugs as the majority (86%) of the farmers applied these remedies incorrectly.

- The predictor “roads” is perhaps one of the most important predictors of adoption in the antibiotics model. Antibiotics are urgently needed when an animal is already sick. In these cases, farmers must obtain them in a very short time, therefore the

availability and accessibility of roads become an important determinant for the adoption of this technology, as medication is no longer available at the sheering sheds.

- Vaccine technology showed the lowest adoption level of the four medication groups studied, which confirms that small ruminant farmers prefer curative intervention above preventative measures.

- When the subsidised veterinary surgeon services, medication and good information were withdrawn from the sheering sheds (Old Qwaqwa) and the farmer days (New Qwaqwa), it is hypothesised that it became too expensive for the farmers to attain the necessary information on the correct use of these drugs because of the longer distances they have to travel to obtain it.

- The high number of variables that emerged as predictors for the adoption in the different models is an indication that the same farmers tend not to be full adopters of all the different livestock veterinary technologies. The fact that only 20 per cent of the farmers were adopters of veterinary surgeon services as well as full adopters of external parasite remedies and partial adopters of internal parasite remedies, antibiotics and vaccines, confirms this conclusion.

8.3 RECOMMENDATIONS

From the conclusions presented above it is clear that something will have to be done to improve the situation of small ruminant farmers. Policies will have to be formulated and further research conducted. This section provides a few suggestions/recommendations in this regard.

8.3.1 POLICY

The following aspects may be considered when technology transfer and adoption policies are formulated to accelerate the adoption of livestock veterinary technologies amongst small ruminant farmers in agricultural development programmes:

- Policies to protect the natural resource base of Qwaqwa by controlling the urban expansion of townships, are urgently needed.

- In formulating technology diffusion policies, special attention must be given to ways of increasing farming efficiency as more efficient farmers (technically and financially) tend to adopt more livestock veterinary and medication technologies. The diffusion of new and adapted technologies capable of generating technical and financial incentives is essential. The development of training programmes for farmers to assist them in improving their farm management skills, farming efficiency as well as the correct usage and management of livestock veterinary technologies must also be considered.

- Future technology diffusion programmes on veterinary surgeon services, internal parasite remedies and vaccines must focus more on sheep farmers as their needs are higher than goat farmers. This is a potentially successful target group where diffusion of livestock veterinary technologies should have higher acceptance.

- Special attention must be given to the development of a functional road and transport net-work in Qwaqwa. This is essential to reduce transaction costs of input and output, supply of services and information flow on new technologies.

- Training programmes aiming at the correct usage of medication technologies must be developed and presented to farmers. Competent extension officers, animal health officers and more progressive farmers must be used in this training programmes. Priority must be given by policy-makers to the development and implementation of these programmes.

- Chairpersons of sheering associations can play a very important role in providing better information and logistical assistance to farmers in Qwaqwa in future technology transfer programmes. They must also be acknowledged in future training programmes on development of agriculture. These persons are normally willing to fulfill a very important role in livestock veterinary technology diffusion with little financial assistance. Logistic assistance to supply them with more information,

support and training to stimulate farmer-to-farmer diffusion of new technologies is essential to ensure a long-term sustainability of such programmes.

- The improvement of technology transfer and adoption will depend on the re-establishment of a strong and efficient extension service net-work on the former homelands. In order to achieve this, the government may have to consider the following aspects and actions:

  - The reinstitution of a permanent veterinary surgeon and experienced extension and animal health officers provided by the provincial Department of Agriculture at the shearing sheds (Old Qwaqwa) and the farmer days (New Qwaqwa).

  - Continuous training of the existing extension and animal health officers to meet the needs of the farming community and build their human capital capacity.

  - Developing training and extension programmes in accordance with the needs of the farmers in collaboration with the farming community.

  - The implementation of an affordable minimum herd health prophylactic package (basic vaccination and parasite control) with the involvement of the farming community.

  - Looking at ways to develop more self-sustainable extension services. It is a fact and economic reality that extension services for small scale farming in Africa is receiving increasingly less support by governments.

  - Developing the local human capital capacity may be essential to improve adoption of new livestock technologies. Promoting farmer-to-farmer extension may be a way of achieving self-sustainability of extension programmes. One way of doing this, is by means of the development of specific training programmes focussing on the sheering association chairpersons and younger, more progressive and better educated farmers by involving them more in technology diffusion in their farming communities. Sheering association chairpersons are already playing a very active

role in the provision of critical technical and financial information for decision-making and usage of new medication technologies.

- Motivating farmers by means of supporting the adoption of affordable minimum herd health prophylactic packages, to control the most frequent diseases and parasites.

- Developing informal education programmes (literacy and arithmetic) as well as basic management training for farmers, to support the adoption and correct usage of medication technologies, as the present level of education is a major constrain to correct adoption.

8.3.2 FURTHER RESEARCH

Further research on the following aspects is necessary:

- **Characteristics of potential adopters**: It is important to identify the characteristics of potential adopters as well as factors preventing adoption of profitable farming technologies in rural farming and agricultural development areas, as well as in the former homelands of South Africa. This is the ideal target group for future successful diffusion programmes to progressively alleviate poverty in rural areas of the country. Studies in Sudan (Nichola, 1994) and in Nevada (Bhattacharyya *et al*., 1997) revealed that adoption emerges once the variables preventing adoption are uplifted. It is further important to consider the use of the suggested adapted definition of adoption in future studies on these types of farmers. Additional transport costs increase the price of inputs or services, which cause the supply of inputs or services to become less elastic. Ignoring these facts may lead to policy recommendations that could not solve the real problems.

- **The economical advantages of prophylactic programmes for small ruminants.** Research on the development of a training programme for livestock farmers, which emphasises the economic advantages and incentives of prophylactic medication

technology adoption is of great importance. This action may contribute towards productivity, improvement and alleviation of poverty in rural areas.

- **The impact of improved farming efficiency**: Technical and financial efficiency emerged as important contributors towards adoption of livestock veterinary technologies in this study. Research on the development of training programmes on ways to improve farming efficiency may also contribute to the adoption of livestock veterinary technologies and other agricultural technologies, which should increase the wealth of rural farmers with an accompanying improvement of rural economies. The importance of improved efficiency (technical and financial) in the technology transfer and adoption process as determined in this study, need special attention to increase the incentives derived from new technologies.

- **Effect of the level of entrepreneurial and creative skills on technology adoption**: In studies on technology transfer and adoption (Bird, 1989; Cromie & O'Donaghue, 1992; Maasdorp, 1992) it was found that the level of entrepreneurial and creative skills is an important determinant for the adoption of agricultural technologies. Questions asked in this study did not manage to distinguish between entrepreneurs and non-entrepreneurs. Research on the behaviour of former homeland and emerging small ruminant farmers to determine critical factors contributing to the development of entrepreneurial and creative skills, are important to establish sustainable agricultural development programmes in rural areas of South Africa. The development of training programmes in improving the entrepreneurial and creative skills of former homeland and emerging small ruminant farmers can then be developed from the results obtained.

- **Efficiency of traditional livestock medication**: Traditional livestock medication as well as their efficiency, were aspects not attended to in this study because of the low number of farmers using them in combination with modern medication. More research must be done on the efficiency of the locally used herbal and other common remedies.

- **Efficiency of extension services**: Comparative studies on the efficiency of new veterinary and extension services, compared to the old services (before 1994), as well as comparative studies between regions, provinces or even similar communities could be important when advising policy-makers on the approach they can follow in developing rural agriculture in South Africa.