# Adoption of Veterinary Technologies Amongst Sheep and Goat Farmers in Qwawqa, South Africa

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# ADOPTION OF VETERINARY TECHNOLOGIES AMONGST SHEEP AND GOAT FARMERS IN QWAQWA, SOUTH AFRICA

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**ABSTRACT**

*Technological breakthroughs in agriculture after the Second World War mainly concentrated on crop production (wheat, rice, and later maize). In the livestock production sector, besides the substantial improvements in the poultry and dairy production systems, the development of the other livestock technologies was neglected, due to lower returns when compared to those on crop technology. Nevertheless, the usage of livestock veterinary technologies such as veterinary services and medicines remains important for livestock production as animal diseases are a major cause of poor productivity and high mortality rates, which are major constraints to improve food security. The reasons for poor adoption of livestock veterinary technologies amongst livestock farmers all over the world are not fully understood. There is a generally accepted perception amongst veterinary practitioners that these farmers "react on what they see" when it comes to the adoption of these technologies and prefer a therapeutic approach rather than a preventative one. This hypothesis was never before scientifically tested. This study proved this hypothesis for the first time.*

*The results suggest that medication technologies are mainly adopted once the problem becomes visible. Sheep and goat farmers (small ruminant farmers) in the former homelands only treat their animals for external parasites (ticks and mites) when they can see them on the animal's skin and wool. No farmer in this area adopts a prophylactic approach in preventing external parasites. This attitude explains a much higher adoption of external parasite remedies than internal parasite remedies, as well as a higher adoption of antibiotics (therapeutic medicine) than vaccines (preventative medicine). "Small ruminant farmers react on what they see when it comes to disease control."*

## INTRODUCTION

Technological breakthroughs in agriculture during the first three decades after the Second World War mainly concentrated on crop production (wheat, rice, and later maize) (Hayami & Ruttan, 1985). In the livestock production sector, besides the substantial improvements in the poultry and dairy production systems, the development of the other livestock technologies was neglected, because the returns on crop technology were much larger than those of livestock technologies (De Boer, Knipscheer & Kartamulia, 1992). Nevertheless, the usage of veterinary services and medicine technologies remains important for any livestock farmer, as disease and high mortality are major constraints on livestock production and food security in Southern Africa (McKinnon, 1985). This leads to the major problem that farmers produce below capacity.

To the author's knowledge, very little research has been done in South Africa on the general characteristics of livestock farmers and on the adoption of veterinary medication technologies. Much less is known about the characteristics of the former homeland small ruminant farmers farming with sheep and/or goats) adopting medication (external and internal parasite remedies, antibiotics and vaccines) technologies. This is very strange for a country where most of the land[1] is not suited for crop production, and therefore livestock farming, based on ruminant production, is the main possibility to convert the natural pastures into human food.

The literature on diffusion (transfer) and adoption of agricultural technologies suggests that the adoption behaviour of farmers is explained by farmer and household characteristics (Wheeler & Ortmann, 1990), perceptions about agricultural technology (Feder, Just & Zilberman, 1985) and institutions and infrastructure available (Hayami & Ruttan, 1985). Identifying the variables that determine the adoption of medication technologies and differentiate between farmers who adopt at various levels (over, fully, partly or non) and those who do not, can have promising, cost-saving and economic impacts on the planning and execution of future extension programmes. Disease prevention is more economical than treatment and some diseases can not be treated. In these cases the use of external and internal parasite remedies as well as vaccines as a prophylactic treatment are the most effective means of disease control (Hunter, 1993).

The reasons for poor adoption of livestock veterinary technologies amongst livestock farmers all over the world are not fully understood. There is a generally accepted perception amongst veterinary practitioners in South Africa that these farmers "react on what they see" when it comes to the adoption of these technologies and prefer a therapeutic approach rather than a preventative one (Erasmus, 1998; McDonald, 1998; Naude, 1998). However, this hypothesis was never before scientifically tested. In this paper an attempt is made to test the hypothesis that small ruminant farmers react on what they see when it comes to the usage of livestock medication and prefer to treat diseases rather than to prevent them.

## METHODOLOGY

In studies on technology adoption, discrete choice models – probit, logit and tobit (Feder *et al.,* 1985; Lin, 1995) – are widely used. The logit model was used in this study to determine predictors for the adoption of veterinary technologies.

No previous studies were done on the diffusion and adoption of medication technologies in the former homelands, therefore no precedent exists to provide a guide in the selection of relevant variables to either replicate or refute previous results. This brings to pass that a larger number of explanatory variables will be considered in the models than would have been done under other circumstances. The selection of variables as possible predictors for the adoption of veterinary technologies were based on the adoption-diffusion theory and past empirical work. A questionnaire was developed to obtain information at farm level on these variables from randomly selected small ruminant farmers in Qwaqwa. A proportionally stratified sample of 99 small ruminant farmers (63 in the Old Qwaqwa and 36 in the New Qwaqwa) was selected.

Qwaqwa[2] was chosen as study area, as it is mainly a livestock production area with very little high quality arable land for cash crops (Vrey & Smith, 1980). The farmers in the sample operate on two basic land tenure systems, namely communal farming (Old Qwaqwa) and farming on consolidated land which is rented from the government with the option to buy it (New Qwaqwa). A description of the study area as well as the medication technology transfer programmes are fully described by Nell (1998).

The age of the farmers was the only variable that had a normal distribution and therefore the mean was used as a summary statistic. All the other variables had skew distributions and therefore the median was used as it is a more representative criterion for this type of data set (Steyn, Smit & Du Toit, 1994). The explanatory variables of adoption of the livestock veterinary technologies were divided into two sections, namely continuous and categorical. Two tests were used to determine the significance level of the differences between the adoption groups for each of the fourteen continuous explanatory variables, namely the t-test in the case of normally distributed variables and the Mann-Whitney test for variables with skew distributions. To determine the differences between the adoption groups for each of the twenty categorical explanatory variables, the Chi-square Test or Fisher's Exact Test was used. Once the variables that could possibly differentiate between two or more adoption groups were identified (p□0,15; possible predictors), logit models were fitted with these variables as independent predictors for technology adoption. Stepwise regression was used in the modelling (Hosmer & Lemeshow, 1989) to identify those variables, which significantly (p□0.15) contribute to the adoption of livestock veterinary technologies.

The definitions of the different levels of adoption of medication technologies (over, full, partial, wrong and non-adopters) and of veterinary surgeon services (adopters, potential adopters and non-adopters) are described in detail in the research by Nell (1998). The broader definition for the different adoption levels of **medication technologies** are as follows:

**Adopter/Full adopters:** a farmer using the specific medication technology at the recommended level.

**Over-adopter:** a farmer using more than the recommended level of the specific medication technology.

**Partial adopter:** a farmer using less than the recommended level of the specific medication technology.

**Wrong adopter:** a farmer using the wrong medication for a specific disease or sickness.

**Non-adopter:** a farmer not using the specific medication technology.

Adoption levels of **veterinary surgeon services** were defined as follows:

**Adopters** (n=51): use veterinary surgeon services at least once a year.

**Potential adopters** (n=35): would have used veterinary surgeon services if they were available or accessible.

**Non-adopters** (n=13): do not use and would not use veterinary surgeon services in any circumstance.

The conventional way of identifying non-adopters in adoption studies is to classify all farmers not using a technology as non-adopters assuming that the technology is available and accessible (elastic). In this study the definition of a potential adopter was considered as this technology is not easy accessible or available to all farmers (inelastic). The potential adopters were grouped first with the non-adopters (n=48) (conventional definition) and then with the adopters (n=86) (adapted definition) in two different analyses to identify the variables contributing to adoption of the specific group of adopters. This approach was necessary as policy changes in the Department of Agriculture, after the general election in 1994, resulted in the rationalisation of a Defence Force veterinary surgeon, the government veterinary surgeons and many animal health officers and experienced extension officers in Old Qwaqwa (Olivier, 1998). Presently only one private veterinary surgeon runs a clinic in the area which is open twice a week for three hours (McDonald, 1998). Shearing sheds situated in the mountains are mainly run by shearing associations themselves and visits from a veterinarian or an extension officer are quite rare (Komako, 1998).

## RESULTS AND DISCUSSION

The different levels of adoption of the five livestock veterinary technologies considered (Nell, 1998) are summarised in Table 1. It is evident that the small ruminant farmers in Qwaqwa (Old and New) adopt much less vaccines than any other livestock veterinary technology considered in this study, indicating that these farmers prefer to adopt therapeutic to prophylactic interventions to control animal diseases. These farmers prefer a reactive rather than a pro-active health management attitude.

**Table 1 Adoption levels of veterinary technologies by small ruminant farmers in Qwaqwa**

| Livestock Veterinary technology | Percentage adoption (%) | | | | |
|---|---|---|---|---|---|
| | Over-adopters | Full adopters | Partial Adopters | Non-adopters | Wrong adopters |
| External parasite remedies | 18 | 67 | 13 | 0 | 2 |
| Internal parasite remedies | 15 | 12 | 71 | 2 | 0 |
| Antibiotics | 0 | 16 | 70 | 14 | 0 |
| Vaccines | 0 | 0 | 83 | 17 | 0 |
| | Adopters | Potential adopters | | Non-adopters | |
| Veterinary surgeon services | 52 | 35 | | 13 | |

The first technology, external parasite remedies, refers to remedies used to control external parasites. The characteristics of the adoption groups are presented by using the definition of over-adopters (O/A;18), full adopters (F/A;66), partial adopters (P/A;13) and wrong adopters (W/A;2) (Nell,1998). The fact that there were 85 % O/A and F/A and no non-adopters, is a clear indication that in general, these farmers have adopted the use of this type of medication technology quite well. According to Venter (1998), the relatively high sales of external parasite drugs in Qwaqwa further support these considerations

The second technology, internal parasite remedies, refers to remedies used to control internal parasites. The characteristics of the variables studied for the different adoption groups are presented by using the definitions of over-adopters (15), full adopters (12), partial adopters (70) and non-adopters (2) (Nell, 1998). The presence of only two non-adopters is an indication that farmers in general have adopted the use of this type of medication reasonably well. However, the fact that 71 % of the farmers are only partial adopters, indicates that farmers treat small ruminants less frequently than necessary for an efficient preventative programme against internal parasites. This means that internal parasite remedies are not used as a preventative medication but rather as a therapeutic one, mainly when the external effects of the internal parasites become visible, which was confirmed in the questionnaire.

The third technology, antibiotics, refers to medication used to treat animals showing signs of diseases other than parasites (external or internal). The characteristics of the adoption groups are presented by using the definition of full adopters (16), partial adopters (69) and non-adopters (14) (Nell, 1998). The high level of full and partial adopters (86%) for this technology is an indication that farmers are willing to adopt this relatively expensive medication for therapeutic treatments in extreme cases and perhaps as last resource to prevent animal deaths.

The fourth technology, veterinary surgeon services, refers to visits to or from a veterinary surgeon. The characteristics of the adoption groups are presented by using the definition of adopters (51), potential adopters (35) and non-adopters (13) (Nell, 1998). The fact that 86 of the 99 farmers used or would have used veterinary surgeon services mainly to get help for a sick animal if they were available and accessible, was also an indication that farmers are aware of the benefits of a therapeutic intervention to try to prevent animal deaths; however, for a relatively large proportion of the farmers this technology is not accessible or available.

The fifth technology, vaccines, refers to medicines used to prevent infectious diseases. For this reason, vaccines are exclusively prophylactic medicines. The characteristics of the adoption groups are presented by using the definition of full adopters (0), partial adopters (82) and non-adopters (17) (Nell, 1998). The fact that there are no full adopters of vaccine technology, but only partial and non-adopters, is an indication that the level of adoption of this technology is quite low amongst small ruminant farmers in Qwaqwa. It also indicates that the diffusion of vaccination technology was not efficiently done in the past. The withdrawal of veterinarians, competent extensionists and animal health officers of the Department of Agriculture from Qwaqwa after 1994, affected the efficiency and quality of the extension services. This, associated with the poor accessibility or availability of veterinary surgeons and suppliers of medication technologies, had a negative impact on the adoption and usage of vaccines by the local farmers. This finding is supported by the fact that according to Agri-Mark's yearly sales figures (Venter, 1998), the volume of sales of vaccines by the existing suppliers of inputs in the area have the lowest value of all four types of medication studied. This means that vaccines are perceived by the local farmers as the least important group of medication, which explains why the adoption of this type of medication is so poor. Furthermore, it is not in the best interest of suppliers of therapeutic drugs (with higher profit margins than vaccines) to advocate the use of efficient prophylactic programmes that will reduce the sales of therapeutic medicines. On the other hand, the reported mortality rate (real or perceived by the farmers) is very low (Nell, 1998). This aspect also has a very negative effect on the adoption of a disease prevention programme, as the cost-effectiveness of such an intervention is not easily realised by these farmers, that keep very poor financial records. According to Erasmus (1998), livestock farmers in the former homelands react on what they see when it comes to adoption of medication technologies for livestock production and prefer to treat rather than to prevent diseases.

A summary of the significant variables (p□0.15) 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 2. The first and outstanding feature of these results is that none of the variables (predictors), except type of farmer (sheep livestock units [LSU's] as percentage of small ruminant LSU's), which emerged as significant adoption predictors in one model, was a predictor in any of the other six models. This is a further indication that the adoption predictors of preventative remedies differs from therapeutic ones.

*Table 2:* **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 Pot/A & N/A | | A & Pot/A vs N/A | | 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 | |
| | Para-meter | P>Chi* | Para-meter | P>Chi* | Para-meter | P>Chi* | Para-meter | P>Chi* | Para-meter | P>Chi* | Para-meter | P>Chi* | Para-meter | 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 previous year | | | | | | | | | | | 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 category "**infrastructure**" has four variables which to some extent has a significant influence on the adoption of five of the seven groups of livestock veterinary technology models. **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. These results indicate that farmers with more access to transport and roads favour the adoption of therapeutic technologies (antibiotics) to treat visibly sick animals, rather than prophylactic ones (vaccines) to prevent diseases. This result coincides with the result of veterinary surgeon services under the conventional definition of adoption, as well as the transaction costs theory by Von Thünen (Barlowe, 1978), who refers to the barrier of increased transportation costs for technology adoption.

## CONCLUSIONS

The results of this study indicate that small ruminant farmers in Qwaqwa have been exposed to livestock veterinary technology diffusion programmes. A vast majority of the farmers are aware of these technologies; however, the level of correct technology adoption is far from desired. There are no full-adopters for all five technologies considered and the percentage of correct adopters for each technology (adopters or full-adopters) is relatively low.

The lack of the significance of extension visits for veterinary surgeon services and the adoption of medication technologies is an indication that these services are not having an effective role in the correct transfer - adoption process of livestock veterinary technologies in Qwaqwa. The policy changes after 1994 resulted in the removal of competent extension officers and veterarians from the area, and have compromised the efficiency of the technology transfer programmes in the area. The small ruminant farmers in Qwaqwa tend to react on what they see when it comes to disease control and prefer to treat visibly sick animals rather than to prevent animal diseases by using vaccination and a prophylactic programme for internal and external parasites.

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## NOTES

1. Fifty per cent of South Africa is classified as arid, 40 % semi-arid and 10 % sub-humid (Unesco, 1977).
2. Qwaqwa refers to two sections, the original Witsieshoek, an area of 50 172 ha, which is described as Old Qwaqwa (DBSA, Sec.2, 1985; Vrey & Smith, 1980), and New Qwaqwa, an area of 15 342 ha, an old portion of the Harrismith district which became part of Qwaqwa in 1984, as well as 59 000 ha in the Bethlehem/Harrismith districts which were divided into 115 farms.

## BIBLIOGRAPHY


Barlowe, R. 1978. *Land resource economics: The economics of real estate*. 3rd ed. Englewood Cliffs, New Jersey: Prentice-Hall Inc.

Development Bank of Southern Africa (DBSA). 1985. *Qwaqwa development information – Section 1-10.* Midrand: DBSA and Qwaqwa Government.

De Boer, J., Knipscheer, H. & Kartamulia, I. 1992. Constraints to technology transfer for animal science research in Indonesia. In: Livestock services for smallholders: A critical evaluation, Seminar proceedings - Yogyakarta, Indonesia, November 1992, pp. 357-359.

Erasmus, J. A. 1998. Deputy Director, Veterinary Laboratory, Department of Agriculture, Kroonstad. Personal communication.

Feder, G., Just, R. E. & Zilberman, D. 1985. Adoption of agricultural innovations in developing countries: A survey. Economic Development and Cultural Change, 33(2):255-298.

Hayami, Y. & Ruttan, V. W. 1985. Agricultural development: An international perspective. Revised and expanded edition. London: The John Hopkins University Press.

Hosmer, D. W. & Lemeshow S. 1989. Applied logistic regression. New York: Wiley.

Hunter, Pamela. 1993. Vaccination for the control of stock diseases in Southern Africa. Pretoria: Pamela Hunter-Oberem.

Komako, Z. January 1998. Chairperson – Tseseng Sheering Association. Personal communication.

Lin, J. Y. 1995. Endowments, technology, and factor markets: A natural experiment of induced institutional innovation from China's rural reform. American Journal of Agricultural Economics, 77(2):231-242.

McDonald, A. 1998. Veterinary Surgeon, Harrismith. Personal communication.

McKinnon, D. 1985. Productive capacity of small ruminants. Proceedings of the Livestock Production Seminar, FAO, Maputo, Mozambique, pp. 156-166.

Naude, J. 1998. Deputy Director, Veterinary Laboratory, Department of Agriculture, Bethlehem. (Before 1994 in charge of veterinary surgeon services in Qwaqwa and now appointed again to attend to veterinary surgeon services in Old Qwaqwa.) Personal communication.

Nell, W. T.1998. *Transfer and adoption of technology: The case of sheep and goat farmers in Qwaqwa.* Unpublished Ph.D. thesis. University of the Orange Free State, Bloemfontein. Also available on the web address: http://www.uovs.ac.za/faculties/agric/centre

Olivier, J. 1998. Director, Eastern Free State Department of Agriculture, Bethlehem. Personal communication.

Steyn, A. G. W., Smit, C. F. & Du Toit, S. H. C. 1994. Moderne statistiek vir die praktyk. Hersiene uitgawe. Pretoria: Van Schaik.

United Nations Educational, Scientific and Cultural Organisation (Unesco). 1977. World map of desertification. United Nations Conference on Desertification Report A/Conf. 74/2. New York: United Nations.

Venter, P. 1998. General Manager, Agri-Mark, Phuthaditjhaba. Personal communication.

Vrey, W. J. H. & Smith, D. J. G. 1980. Die ontwikkeling van Qwaqwa. Geologiese en Landboukundige Potensiaal, 1:1-134.

Wheeler, M. W. & Ortmann, G. F. 1990. Socio-economic factors determining the success achieved among cotton-adopting households in two magisterial districts of KwaZulu. Development Southern Africa, 7(3):323-333.

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