Chapter 1

Background

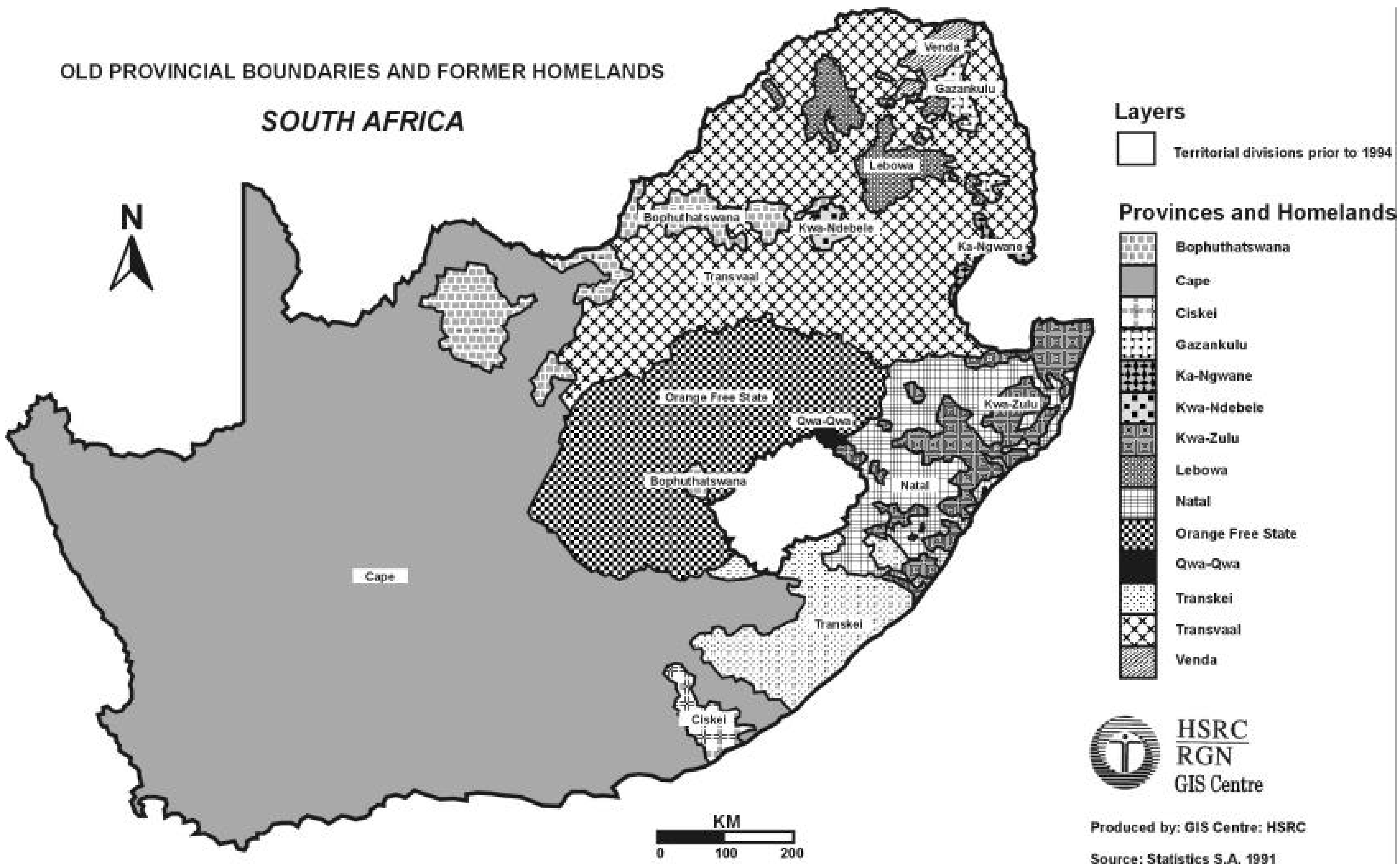
The small ruminant industry of South Africa comprises 36 million units of which 29 million are sheep and six-and-a-half million are goats (Anon, 1999).

Small ruminants, and livestock in general, serve as a stabilising factor in farming especially on marginal lands. Crop farming is so much more dependent on weather and climatic conditions. A maize crop may fail, for example, because of lack of rain whereas sheep and especially goats will be able to withstand a temporary drought. Small ruminants are important for the resource-poor farmer as they serve as an economic reserve. The sale of a few cull animals provides a solution to cash flow problems (own observations, 1998). In addition, small ruminants serve as sacrificial animals for celebrations and other traditional purposes and as a source of food in times of need.

A resource-poor community may be said to be characterised by:

- "At least 60% of the community living below the poverty data line;
- Poor access to facilities, information (literacy, education), infrastructure, finance, agricultural inputs and support services (e.g. access to markets);
- No security of land tenure; …
- Skewed demographics (higher proportions of women, aged, young);
- History of dependency on state-provided services (e.g. dipping);
- Low livestock production and reproduction;
- Needs include better accessibility and affordability of information, products and services" (Krecek et al., 1999). In many cases, resource-poor areas correspond to the so-called homelands of the previous political dispensation (Fig. 1.1).

Fig. 1.1


OLD PROVINCIAL BOUNDARIES AND FORMER HOMELANDS
SOUTH AFRICA
N
Venda
Gazankulu
Lebowa
Bophuthatswana
Kwa-Ndebele
Ka-Ngwane
Transvaal
Orange Free State
Qwa-Qwa
Kwa-Zulu
Natal
Bophuthatswana
Cape
Transkei
Ciskei
KM
0
100
200
Layers
Territorial divisions prior to 1994
Provinces and Homelands
Bophuthatswana
Cape
Ciskei
Gazankulu
Ka-Ngwane
Kwa-Ndebele
Kwa-Zulu
Lebowa
Natal
Orange Free State
Qwa-Qwa
Transkei
Transvaal
Venda
HSRC
RGN
GIS Centre
Produced by: GIS Centre: HSRC
Source: Statistics S.A. 1991

Agricultural development involves increasing the overall productivity and sustainability of the farming system (Norman, 1993). Improved production and utilisation of sustainable technology is necessary to assist resource-poor farming communities to contribute to the nation's food security and to their own social and economic advancement (Connor et al., 1994). Resource-poor farmers have expressed concern that their goats "don't multiply" (B.A. Letty, personal communication, 2001), a statement which conceals poor reproductive performance and low productivity as well as poor herd management and lack of understanding of disease. At the same time, they have also expressed the desire to keep their animals healthy in order to offset the expenses of, for example, hiring land (own observation, 1999).

The importance of gastro-intestinal parasites as major constraints to small ruminant health and production is well recognised world-wide and in Africa. Studies demonstrating this include, for example, those listed in Table 1.1. Gastrointestinal nematodes cause losses owing to mortalities, reduced liveweight gains, poor reproductive performance and condemnation of meat at abattoirs.

Echoing this fact, in September 1993 at a workshop held at the premises of the Foundation for Research Development (now National Research Foundation), interim priorities were set pending finalisation of the proposed new veterinary science research programme (Connor et al., 1994). One such priority was the control of internal parasites.

Barrow (1964), Rossiter (1964), Horak et al. (1976), Horak and Louw (1977), Horak (1978) and Biggs and Anthonissen (1982) have investigated the epidemiology of gastrointestinal helminths in sheep raised under commercial farming conditions within the summer rainfall area of South Africa (Fig. 1.2). Boomker et al. (1994) and Kusina et al. (1999) have studied the parasites of goats kept under resource-poor conditions in South Africa and Zimbabwe, respectively. The studies have indicated *Haemonchus* to be the most important parasite of small ruminants within the summer rainfall area of South Africa. Summer in the Southern Hemisphere may be defined to occur from December to

Table 1.1

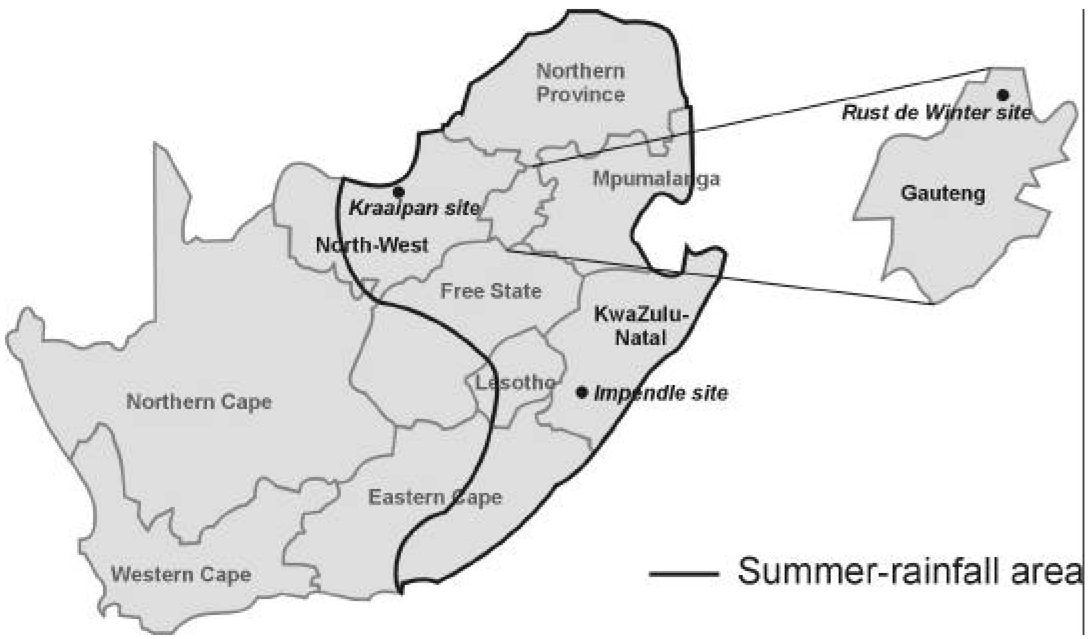
Studies demonstrating the importance of gastro-intestinal parasites as major constraints to small ruminant health and production in Africa

Country	Reference
Botswana	Carmichael, 1972
Cameroon (Bamenda)	Ndamukong et al., 1987
Ethiopia (Asmara)	Tseggai, 1981
Ethiopia (Debre Berhan)	Bekele et al., 1992
Ethiopia (highlands)	Tembely et al., 1996
Kenya	Peeler and Wanyangu, 1998
Kenya (Lolgorien Area, Narok District)	Muenstermann and Tome, 1989
Kenya (Machanga Embu)	Okeyo et al., 1996
Kenya (Nairobi—Limuru—Ruiru area)	Lutu, 1983
Kenya (Naivasha)	Allonby and Urquhart, 1975
Morocco (Middle Atlas, Gharb and Rhamna)	Dakkak and Ouhelli, 1988
Namibia (Kalahari region)	Biggs and Anthonissen, 1982
Nigeria (eastern)	Fakae, 1990
Sierra Leone (Freetown)	Asanji, 1988
Sierra Leone (Freetown)	Asanji and Williams, 1987
Sudan	Yagoup et al., 1981
Tanzania (northern)	Njau, 1987
Tanzania (southern)	Connor et al., 1990
Tropical regions e.g. northern Nigeria	Fabiyi, 1987
West Africa (sub-Saharan)	Zinsstag, 1998
Zimbabwe (Marandellas)	Grant, 1981
Zimbabwe (Mashonaland East Province)	Kusina et al., 1999

February; autumn from March to May; winter from June to August; and spring from September to November (Climatic Information Office, South African Weather Bureau).

Haemonchus occurs in highest numbers from January to April or May, but may be an important species even until July. From February to April, *Haemonchus* occurs increasingly as hypobiotic fourth-stage larvae which allows the parasites to overwinter. When the mean maximum temperature and the monthly rainfall rise above 18°C and 50 mm respectively (Allonby and Urquhart, 1975), conditions are once again favourable for the development of the parasite on pasture. *Trichostrongylus* and *Teladorsagia* prefer the cooler months of the year. *Oesophagostomum* may occur all year round in moderate numbers (Rossiter, 1964), although conditions on pasture are optimal for infective larvae during late summer and autumn (Reinecke, 1983).

Fig. 1.2 : Study sites for sampling



With the emergence of the highly effective broadspectrum anthelmintics over the past three decades, anthelmintics have become the mainstay of worm control in the small ruminant industry. Anthelmintics are often registered for use in goats at the same dosage rate as for sheep (Hennessy et al., 1993a). However, various studies have subsequently indicated differences in the metabolism of the remedies in goats when compared with sheep. As such, the use of sheep dosage rates in goats has been suggested as a reason for the reduced efficacy of the drugs in this species. Oxfendazole has been shown to have a significantly lower systemic availability in goats than in sheep (Hennessy et al., 1993a). A dosage rate of 10 mg kg^{-1} (double the sheep dose rate) is recommended in goats. This is administered as one single dose (5 mg kg^{-1}) followed by two half doses 12 and 24 hours later (Sangster et al., 1991). Closantel has a similar systemic availability in sheep and goats (Hennessy et al., 1993c), but the elimination rate has been shown to be two to three-fold greater in goats than in sheep. This means that the residual action against establishment of infection with gastro-intestinal nematodes is reduced in goats. The reason for the differences in oxfendazole and closantel metabolism in goats than those in sheep is thought to be a result of an enhanced metabolism of the drugs in the liver in goats. Albendazole has also been shown to have a lower systemic availability in goats than in sheep (Hennessy et al., 1993b), but in contrast with oxfendazole and closantel, albendazole is thought to be sequestered to a greater extent in the liver of goats than that of sheep. An increase in the dose rate from 4.75 mg kg^{-1} for sheep to 7.5 mg kg^{-1} in goats has been suggested. A higher dose rate for levamisole of 12 mg kg^{-1} has been suggested for goats compared with the 7.5 mg kg^{-1} for sheep since levamisole is metabolised more rapidly in goats than it is in sheep (Coles et al., 1989). Ivermectin should probably be used at one-and-a-half times the sheep dose rate (0.2 mg kg^{-1}) in goats (Coles, 1997).

The use of the sheep dosage rate in goats has also been proposed as a reason for the development of resistance of gastro-intestinal parasites to anthelmintics (for example, Bjørn et al., 1991), which has become a world-wide phenomenon and is considered to be increasing at an alarming rate. Reports of anthelmintic resistance in goats in Africa have been relatively scant (Table 1.2), although this is probably more a case of insufficient studies having been done than a case of resistance not being present. All of the five goat studies cited in Table 1.2 found resistance in goats kept on research, university or commercial farms where frequent treatments with anthelmintics were given. This differs somewhat from the resource-poor farming set-up where treatments are less intensive or not given at all. Nevertheless, resistance may be present on these farms through the introduction of animals as breeding stock from neighbouring commercial or experimental farms for improving animal production (Maingi et al., 1998; Mwamachi et al., 1995). Resource-poor small ruminant farming in South Africa appears

Table 1.2

Reports of anthelmintic resistance from goats in Africa

Country	Anthelmintic	Breed	Reference	Resistant worm genera
Cameroon	Fenbendazole Thiabendazole	-	Ndamukong et al. (1992)	Strongyles
Kenya	Thiabendazole	East African, Galla, Toggenburg/East African crossbreeds	Njanja et al. (1987)	*H. contortus*
Kenya	Fenbendazole Ivermectin Levamisole	Galla, Small East African	Mwamachi et al. (1995)	*H. contortus* *Trichostrongylus* spp. *Oesophagostomum* spp.
Tanzania	Thiophanate	-	Ngomuo et al. (1990)	*H. contortus*
Tanzania	Albendazole Fenbendazole Thiabendazole	Black Head Persian lambs[a]	Bjørn et al. (1991)	*H. contortus*
Zimbabwe	Thiabendazole	-	Chavunduka (1970)	Strongyles

[a]Anthelmintic efficacy was not tested in the goats, but these were grazed together with the sheep.

to be in the same situation the present commercial farming sector was in about 25 years ago when the first report of anthelmintic resistance in South Africa was published (Berger, 1975). However, even in resource-poor farming areas there appear to be levels of resistance. Van Wyk et al. (1999) reported anthelmintic resistance in sheep on an experimental farm in Lebowa where there was resistance to two compounds from different anthelmintic groups. Varying degrees of resistance also occurred even in four of the five sheep flocks they tested in 1993 on the communal pastures in this region. It is thus essential that plans be made now to prevent the development of the same extent of resistance on the resource-poor farms as exists in the commercial farming sector of South Africa today.

The FAMACHA© system

Waller (1993) cites a number of approaches that may hold promise for the sustainable control of nematodes, including the better use of existing drugs, helminth vaccines, breeding for host resistance, nematode growth regulators and biological control. Included under the better use of drugs are such strategies as specific, epidemiologically based treatments, pasture spelling, alternation of anthelmintic chemical groups, and alternate grazing between species and between age classes within species. Waller and Larsen (1996) stated that non-chemotherapeutic control options needed to be researched and field evaluated as a matter of urgency. In their search for a solution for the threatening problem of resistance of *Haemonchus* to anthelmintics in sheep, Malan and Van Wyk (1992) succeeded in identifying those sheep which were in danger of succumbing to *Haemonchus* infection unless dewormed, through the clinical observation of the colour of the ocular mucous membranes of the sheep. In sheep on irrigated pastures in Badplaas in Mpumalanga Province (an ideal climate for *Haemonchus* infection), they further succeeded in reducing the use of anthelmintics by approximately 90% in these sheep. The corresponding reduction in selection for resistant worms was still greater, as a result of the fact that only those individual animals that were considered in danger of dying were treated with an anthelmintic. There is for the first time a cheap, effective method for identifying the individual animals in a flock that are unable to withstand the worm challenge. This agrees with findings by Barger (1985) which indicated that important nematodes of sheep are overdispersed with more than half of the worms found in less than half of the hosts. Those animals that are not treated still shed susceptible worm eggs on to the pasture. Bath et al. (1996) called the concept the FAMACHA© system after its originator, i.e. Francois "FAffa" MAlan CHArt. They proposed that it be implemented in practice as they found it cheap to apply and easily taught, even to illiterate people. "The technique is very easy and reasonably reliable once learned under guidance of a competent instructor." (Bath et al., 1997.) Testing the FAMACHA© system under other farming conditions was proposed and is needed before this method is validated as an additional tool for integrated worm management. It is described in greater detail in section 2.2 and Fig. 2.2 below.