

Evaluation of the application of a thermostable Newcastle disease vaccine by community volunteers in the North West Province of South Africa

C M E McCrindle^{a*}, S P R Bisschop^b and K Modise^b

ABSTRACT

Participatory research on vaccination of village poultry against Newcastle disease (ND) was carried out in the village of Disaneng, in the North West Province of South Africa. Three application methods for ND Inkukhu[®] vaccine were shown to induce sufficient levels of immunity in back-yard poultry when correctly administered. These are eye-droplet administration to individual fowls, in-feed and in-water administration to small flocks. After a community meeting and group discussion to select methods of vaccination, only 2 of the 3 methods were chosen; the individual administration of droplets into the eyes was considered to be too impractical because back-yard fowls are difficult to catch. Visual and practical training material was prepared and presented to volunteer vaccinators ($n = 23$). Vaccinators were then required to register all the poultry owners in their ward who wished to have poultry vaccinated. Once an indication of the number of chickens to be vaccinated had been made available, ND Nobilis Inkukhu[®] vaccine was supplied to vaccinators free of charge. Community vaccinators were responsible for the organisation of the vaccination campaign, including storage and preparation of vaccine for application. All 9 wards in the village were initially involved with a total of 482 households, owning 6141 chickens, participating. This represented slightly in excess of 60 % of the fowls in the area. Involvement in a 2nd round of vaccinations, 1 month later, was far poorer with only 211 households owning a total of 1636 chickens participating. Serum samples were collected from vaccinated fowls using systematic random sampling and tested for circulating antibodies. The levels of protection varied, with no significant difference found between in-feed and in-water vaccine administration. Volunteer vaccinators were found to be unreliable, easily demotivated, did not keep good records and left the project when offered permanent employment. Contacting them to make arrangements for delivering vaccine was difficult and time consuming. Structured interviews indicated that deaths in poultry and the attitude of the owners probably contributed to the demotivation of the volunteers used as community vaccinators. It was concluded that volunteers are not the ideal choice for vaccination of village poultry against Newcastle disease.

Key words: backyard poultry, community vaccinators, Newcastle disease, participatory research, thermostable vaccine, volunteers.

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INTRODUCTION

Newcastle disease (ND) of poultry is a major cause of economic loss for both commercial and small-scale farmers in southern Africa^{1,3,7,22}. In South Africa, a problem exists where village and backyard owners do not vaccinate their poultry against ND²³. These unvaccinated

fowls pose a threat to the commercial poultry sector as well as threatening food security in low-income rural communities^{2,4,9,22}.

In North West Province 66 % of the population live in rural areas. Most of these people own at least 5–10 chickens which are a source of meat and eggs for the family¹⁴. Disaneng is a large village in the North West Province (NWP) that falls under the Ratlou municipality. The chief of the Disaneng village has headmen for each ward ($n = 9$) to help him run the affairs of the village. The tribal authority is consulted through these headmen or the 2 tribal secretaries.

According to statistical data the total

population of this area is 7861, with 3604 males and 4257 females. The main language is Setswana with smaller proportions that speak Afrikaans, English, Sesotho, Sepedi, siSwati, isiNdebele, isiXhosa and isiZulu. It is reported that 20 % of the people over 20 years of age have no schooling, 31 % have done some primary school, 8 % have completed primary school, while only 10 % have done Grade 12. The percentage of those who acquired higher education is less than 1 %²¹.

Thermostable ND vaccines hold promise for small-scale and village poultry systems in Africa, as maintaining the cold chain is not as critical as with previous vaccines^{13,18–20}. Previous research done with rural small scale poultry farmers and owners of backyard chickens has shown that acceptable levels of immunity could be achieved with ND Inkukhu[®] thermostable vaccine, administered to small flocks through food or water, or by applying it as a droplet to each eye of individual fowls^{9,15}. All 3 of these methods are simple enough for a rural small-scale farmer or a owner of poultry to implement; however, they are not doing so. It was therefore decided to investigate, using participatory methods^{10–12}, whether community volunteers could be trained to vaccinate village poultry.

MATERIALS AND METHODS

Participatory research

Forty to 50 years ago, technology transfer was the gold standard for improving agricultural productivity. Lack of success led to the emergence of participatory methods, where farmers and communities are centrally involved in the research that is needed to improve agricultural outputs and animal health. Linked to this is farming systems research-extension (FSR-E) and farmer participatory research (FPR)^{8,12,17}. Empowering rural and low-income communities by increasing their role in their own development is the central tenet of FPR. Researchers become facilitators rather than leaders and attempt to understand and record the farmers' priorities and limitations in order to solve

^aDepartment of Paraclinical Sciences, Veterinary Public Health Section, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Onderstepoort, 0110 South Africa.

^bDepartment of Production Animal Studies, Poultry Section, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Onderstepoort, 0110 South Africa.

*Author for correspondence.
E-mail: cheryl.mccrindle@up.ac.za

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a research problem in a participatory way. The method was originally proposed by Chambers¹⁰ and has been amplified by other authors in the intervening years, with the incorporation of methods also used by social scientists, such as group work^{8,12}.

After individual consultations and meetings with the key role players in the village of Disaneng, including the Tribal authority and extension officers as well as the headmen of each of the 9 wards – a community meeting was set up on the 12th and 13th of May, 2004. The secretary in the Tribal office was asked to book the Community Hall. A copy of the agenda for the community meeting was faxed to the secretary, who distributed the information verbally, to all the headmen of the different wards ($n = 9$) of the village. In turn, the headmen informed community members during community meetings and also sent messages to schools, shops and gatherings such as funerals. This follows the model described by Bembridge for a communication strategy⁸. The channel of communication for the invitation was thus by word of mouth.

Community meeting and selection of vaccination method

Following a presentation on the results of previous vaccination campaigns using thermostable vaccine and a full description of the 3 methods that could be used (eyedrop, in-feed and in-water administration), the poultry owners were divided into 6 small groups, each representing 1 ward, to answer the question of which method should be used for vaccinating poultry against ND in each ward. The 3 methods of administration have been described in detail by Bisschop *et al.*⁹.

Once the groups had deliberated and reported back to the plenary, consensus was reached on the types of vaccine methods preferred in each ward. The results are shown in Table 1 below.

Among the 3 methods of vaccination presented, only the eye-drop method was not chosen because, according to the farmers, most of the chickens in the village are not housed and so vaccination required running after each and every chicken.

The farmers that preferred the in-water administration of vaccine chose it because:

- fowls are used to drinking immediately after eating;
- fowls may refuse to eat maize porridge because they are used to maize kernels;
- the owner can also withhold water overnight so as to make the fowls very thirsty the following day and they will then readily consume the water containing vaccine.

Table 1: Method of vaccination chosen by each ward in the village.

Ward vaccination	Method of
Thoteng	Feed
Ditshetlhong	Feed
Setlhabaneng	Feed
Ntswaneng	Feed
Botshabelo	Feed
Manawane	Water
Senobolo	Water
Methusele	Water
Senthumole	Water

Those who preferred the in-feed method of administration chose it because

- Since the fowls are in most cases hungry they will not ignore the maize porridge.
- In cases where fowls were being fed, they would withdraw feed overnight so that the fowls would be hungry the following day.
- With this method they would be sure that each and every fowl would get vaccinated as it would be possible to observe them eating the porridge.

Selection of volunteers

The person responsible for the preparation of the vaccine was nominated from each group representing a ward. These persons each needed to have a refrigerator that was continuously working and be able to read and write. It was made clear

that the work was voluntary and no payment would be given.

A 2nd meeting was arranged for skills training of the community vaccinators representing 6 wards. Seven of those trained failed to do any vaccinations, possibly because they had expected payment and did not participate once they discovered it was voluntary. Following the training session, 6 individuals representing the remaining 3 wards were trained at their homes by the researcher. The names, gender, age and level of education of community vaccinators, are shown by ward, in Table 2.

Vaccination of fowls

Fowls were vaccinated 3 times. The 2nd vaccination followed 4–6 weeks after the 1st and the 3rd vaccination was done about 3 months later. Owing to difficulties with contacting the volunteers, the vaccination intervals showed some variation between wards in the same village (Table 3). In 2 of the wards, Manawane and Thoteng, inadequate records were kept of the number of fowls vaccinated during the 3rd vaccine campaign.

Evaluation of immune status using serology

A systematic random sampling method was used to select households where fowls had been vaccinated twice, approximately 1 month after the 2nd vaccination. Three randomly selected fowls from each household were sampled. Thereafter

Table 2: Demographics of community poultry vaccinators ($n = 23$).

Ward	Name	Gender	Age	Education level (grade)
Thoteng	Magadi	F	39	11
	Ntebogang	F	43	9
	Mmemme	F	32	10
	Seitsho	F	54	4
Ditshetlhong	Segametsi	F	36	11
	Ranku	M	32	4
Setlhabaneng	Tshepang	F	24	9
	Galaletsang	F	24	11
	Kedibone	F	49	3
	Nomtsaku	F	50	1
	Ouma	F	47	3
Ntswaneng	Goitseone	M	38	5
	Jeremiah	M	37	0
Botshabelo	Dimakatso	F	37	10
	Maipelo	F	48	4
Manawane	Mothibedi	M	52	7
	Thabang	F	33	12
Senobolo	Mosadiwapula	F	64	0
	Khumalo	M	54	5
Senthumole	Itumeleng	M	35	12
Methusele	Buru	M	34	0
	Lexman	M	30	12
	Mogwase	F	32	0

Table 3: Vaccination campaigns carried out per ward.

Ward	Vaccine 1	Vaccine 2	Vaccine 3	Method used
Thoteng	3 June	19 August	1–7 December**	Feed
Ditshethlong	3 June	22 August	December*	Feed
Setlhabaneng	3 June	17 August	None	Feed
Ntswaneng	4 June	19 August	4–8 January	Feed
Botshabelo	3 June	30 August	28–30 January	Feed
Manawane	14 June	20 Sept	4–8 January**	Water
Senobolo	28 July	24 August	None	Water
Methusele	30 June	22 Sept	None	Water
Senthumole	1 July	None	None	Water

*Vaccinators forgot to fill in the actual dates of vaccination, only the month was indicated.

**Vaccinators did not record the number of fowls vaccinated.

fowls from the same households were re-sampled approximately 1 month after the 3rd vaccination.

Two millilitres of blood was collected from the wing vein in each fowl sampled and stored at 4 °C for transport to the laboratory. Haemagglutination inhibition tests (HI) were performed on the sampled serum according to the method described by Allan and Gough⁶, at the Poultry Reference Laboratory, located at the Faculty of Veterinary Science, University of Pretoria^{5,16}.

A section that was never involved in vaccination was selected as a negative control and bled. It was important to do this as community members, with both vaccinated and non-vaccinated fowls, complained about the death of chickens.

Structured interviews

Data collection from all community vaccinators ($n = 23$) was carried out using structured interviews^{8,14}. The questionnaire was translated into the vernacular, so that the vaccinators would be able to understand and respond to the questions correctly. This was to gain knowledge of sociological factors affecting the implementation of vaccination campaign within the community. In addition, a structured interview was conducted with a random sample of 63 community members in all 9 wards whose chickens were vaccinated, to evaluate the community vaccinator and the vaccine campaigns.

RESULTS

The total number of chickens vaccinated via each of the vaccination application routes as well as the total number of chickens vaccinated in each of the 3 vaccination campaigns is shown in Fig. 1.

As can be seen from Fig. 1, a total of 6234 chickens were vaccinated during the 1st vaccination campaign. This number declined dramatically to only 2018 birds in the 2nd campaign and 1509 by the 3rd campaign. In the 1st campaign approximately 66 % ($n = 4102$) of the fowls were

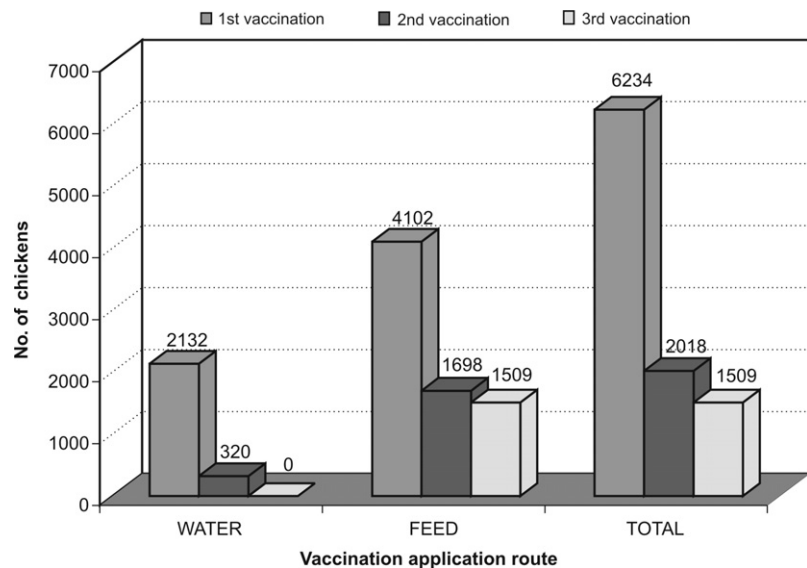


Fig. 1: Number of chickens vaccinated via each of the vaccine application methods (in-feed and in-water) in 3 successive vaccination campaigns.

vaccinated using the in-feed application method.

The number of households (poultry owners) that participated in each vaccina-

tion campaign, as well as the vaccine application route used, is shown in Fig. 2.

A total of 479 households took part in the 1st vaccination campaign. The number

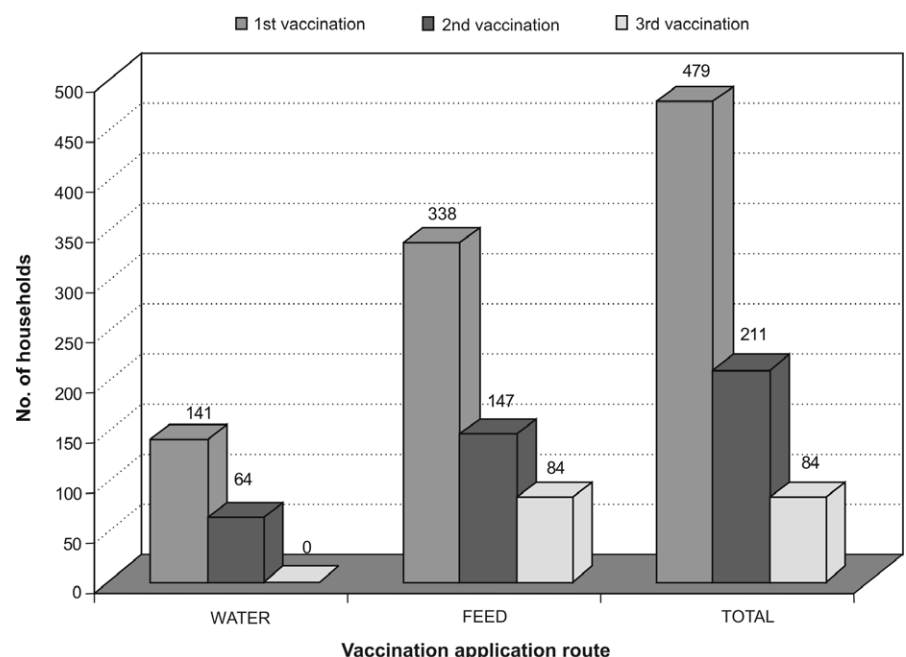


Fig. 2: Number of households participating in successive vaccination campaigns.

Table 4: Results of HI tests carried out on serum from vaccinated poultry (per ward).

Ward	Mean 1*	% Protection 1* (%)	Mean 2**	% Protection 2** (%)	Method used
Thoteng	2.76	35	3.69	71	Feed
Ditshetlhong	0.78	11	2.45	46	Feed
Setlhabaneng	2.53	62	***	Not bled***	Feed
Ntswaneng	1.05	11	2.38	46	Feed
Botshabelo	2.40	50	1.62	1	Feed
Manawane	2.30	44	1.06	0	Water
Senobolo	2.13	26	***	Not bled***	Water
Methusele	3.09	66	***	Not bled***	Water
Average	2.13	38	2.24	33	

*Mean 1 = Mean serum antibody titres after the 2nd vaccination, sampled October 1, 2004.

**Mean 2 = Mean serum antibody titres after the 3rd vaccination, sampled February/March 2005.

***Not vaccinated for a 3rd time.

of households decreased to 211 and to 84 households in the 2nd and 3rd vaccination campaigns, respectively.

It can be seen that more households participated in the in-feed application method in every vaccination campaign (Fig. 2). Comparing Fig. 1 with Fig. 2, it can be observed that the number of participating households decreased more quickly than the number of chickens. Generally, in subsequent vaccination campaigns, the number of chickens per participating household increased slightly, indicating that poultry farmers with larger flocks remained in the project.

As the number of households (and therefore fowls) sampled had changed due to non-compliance with the 3rd vaccination, frequencies have been converted to percentages for the sake of comparison of titres following the 2nd and 3rd vaccination (Table 4).

In 2 of the wards, Setlhabaneng and Methusele, the HI titres of the chickens were higher after the 2nd vaccine and it was suspected that this may have reflected that a virulent field virus had challenged the chickens. An outbreak of virulent ND in these 2 wards may have been the reason for deaths in fowls, described as a constraint to further vaccination by those who were asked to evaluate the success of the campaign. The unexpectedly low titres obtained in fowls from Manawane and Botshabelo after the 3rd bleeding may reflect dishonesty on the part of vaccinators who did not actually re-vaccinate the fowls as claimed, or they may have presented new fowls for bleeding.

There was an increase in the average titre of antibodies in flocks that had been vaccinated using in-feed as well those that used in-water administration. No significant difference was found between the 2 methods. However, no comparison could be made after the 3rd vaccination as no in-water vaccinations were repeated for a 3rd time.

Structured interviews with vaccinators and the community

Data on the demographics and attitudes of the volunteer vaccinators was collected using structured interviews (summarised in Table 2). More women than men participated. When asked about the decline in participation after the 1st vaccination campaign, vaccinators said that many fowls died after the 1st vaccination campaign and owners became angry, the farmers wanted the vaccinators to deliver the vaccine to their houses and some farmers wanted the state to vaccinate poultry for them. Some of the vaccinators also found paying work inside and outside the village, e.g. water and electricity supply projects, and left the project.

Questions on previous experience with poultry diseases revealed that vaccinators consulted with animal health technicians and local cooperatives and made use of stock remedies. Most vaccinators recognised diseases like ND and Infectious Bursal Disease. The reasons given for volunteering were so as to help their community and also because there were chickens dying in their wards (probably of ND) and they expected that vaccination would stop the mortalities. If ND vaccines were provided free of charge, vaccinators felt it would be they or the headmen who would be able to make the vaccination campaign sustainable.

Structured interviews with randomly selected community members from all the sections showed that most households in the village had backyard poultry. Almost all had heard of the campaign by word of mouth and those that did not vaccinate said that they were not at home at the time or were doing something else at the time of the 1st vaccination. They were ambivalent about the success of the campaign and did not want to commit themselves.

DISCUSSION

Approaching the community at Disaneng *via* the traditional tribal structure was highly effective in that over 60 % of the poultry owners agreed to vaccinate their chickens if this was available at no cost. Good cooperation was also obtained during the community meetings and group discussions. The training was successful, the skills needed for vaccination were in place and volunteers were initially motivated. It was also demonstrated that a mechanism could be found to supply vaccines at a central point to vaccinators – either by means of state subsidised or private services.

However, thereafter there were several constraints to success:

- Although the vaccinators promised to collect the vaccines at a central point, they did not do so. In the 1st vaccine campaign they collected the vaccines at the community hall. During the 2nd and 3rd vaccine campaigns, a few ($n = 5$) came to the hall, but the researcher had to deliver the rest personally to each vaccinator at their houses – this may not be practical on a large scale.
- Even after the 1st vaccine, 1 ward's records appeared as if they were fabricated. Thereafter records became a problem (see Tables 3 and 4).
- Volunteers from only 8 wards gave a 2nd vaccination. The 3rd vaccination was carried out by volunteers from only 5 wards. Only 3 of these kept full records and the 4th one only recorded the number of households that participated.
- The number of chickens varied from one vaccination to another. As they were not marked, it is possible that some were chickens that had not previously been vaccinated. This movement of poultry in and out of a flock, and the fact that not every bird is caught or vaccinated every time, was the main reason why the birds were vaccinated every 3

months. However, it did not solve the problem as the titres were still not consistently high enough for protection.

Community vaccinators were able to vaccinate chickens, but might achieve better success with an even more resilient product. They would also probably cooperate better if paid for their services – either by external agencies or by community members, especially if revaccination is required every 3 months. Unless adequate protection levels were rapidly obtained in response to vaccination (preferably the 1st vaccination), it might be difficult to justify the costs of vaccination to community members in a situation where virulent ND outbreaks occur fairly often.

Levels of immunity to ND measured using HI results from serum samples collected following vaccination by community volunteers, showed much lower levels of protection than those achieved when experienced staff vaccinated poultry and traveled from 1 point to another in a vehicle⁹. Although volunteer vaccinators were instructed to store vaccine in the refrigerator, it is not possible to determine whether or not this actually happened. In at least 1 case a community vaccinator admitted that although she had a refrigerator she had not switched it on, as there was nothing else in it. Vaccine was generally collected from a central point in each ward during vaccination campaigns and then vaccinators would walk home with it. In many cases vaccine might not have reached fowls within an hour of reconstitution.

Structured interviews with volunteer vaccinators showed that they had become very demotivated, particularly because, despite their hard work, mortalities still occurred in vaccinated flocks and some received harsh criticism from poultry owners who said that they would prefer state veterinary staff to vaccinate. The vaccination campaign did not meet their expectations for a rapid end to poultry mortalities.

CONCLUSIONS

ND Nobilis Inkukhu[®] thermostable vaccine can be used successfully to immunise village chickens against ND⁹. Given the constraints in backyard poultry systems, including relatively high costs of vaccination and transport to owners of small flocks (<100 birds), it is probably not the ideal product, and further investigation into alternative products is still merited. Vaccines that are more robust after re-constitution and can be supplied in smaller quantities than 500 doses, or that give sufficiently high titres after a single annual vaccination, would be valuable.

Much further work is required to make

South African policy makers aware of the importance of village/backyard poultry production as a source of protein and food security for the poor.

It was concluded that it is possible to train lay people to vaccinate poultry against ND and that the preferred method is probably in-feed administration, as this was most sustainable during the study. Use of volunteers as vaccinators was not demonstrated to be successful because insufficient fowls attained a protective level of immunity. This was probably because the volunteers were demotivated, did not keep records, could not communicate well or motivate the community – even though they were given sufficient training in the actual skills required to vaccinate poultry against ND. This is most important because it means that for significant protection of backyard chickens against ND there are 2 options: either the state must find the resources to pay vaccinators to do the work, or owners of chickens must be motivated and trained to do it themselves.

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REFERENCES

1. Alders R G 2000 Strategies for vaccination of family poultry against Newcastle disease in Africa. *Second IAEA/FAO Research Coordination Meeting on 'Improvement of Health and Management of Family Poultry Production in Africa'*, 4–8 September 2000, Morogoro, Tanzania. Online: <http://www.fao.org/docrep/006/y5162e/y5162e06.htm> (accessed September 2007)
2. Alders R G 2001 Sustainable control of Newcastle disease in rural areas. In Alders R G, Spradbrow P B (eds) *SADC Planning Workshop on Newcastle Disease Control in Village Chickens*. Proceedings of an International Workshop, Maputo, Mozambique, 6–9 March 2000. *ACIAR Proceedings* No. 103, Canberra: 80–87
3. Alders R G, Dos Anjos F, Bagnol B, Fumo A, Mata B, Young M 2002 *Controlling newcastle disease in village chickens: a training manual*. *ACIAR Monograph* No. 86, Canberra
4. Alexander D J, Gough R E 2003 Newcastle Disease and other avian paramyxovirus and pneumovirus infection. In Saif Y M *Diseases of Poultry* (11th edn). Iowa State University Press, Iowa: 63–99
5. Alexander D J, Bell J G, Alders R G 2004 *A technology review: Newcastle disease – with special emphasis on its effect on village chickens*. *FAO, Rome*

6. Allan W H, Gough R E 1974 A standard haemagglutination inhibition test for Newcastle disease. *Veterinary Record* 95: 120–123
7. Bagnol B 2001 The social impact of Newcastle disease control. In Alders R G, Spradbrow P B *SADC Planning Workshop on Newcastle Disease Control in Village Chickens*. Proceedings of an international workshop held in Maputo, Mozambique, 6–9 March 2000. *ACIAR Proceedings* No. 103, Canberra: 69–75
8. Bembridge T J 1991 *Practical guidelines for agricultural extension workers: a field manual*. Development Bank of Southern Africa, Halfway House: 13–17
9. Bisschop S P R, Mogoge B L, Thekisoe M M O 2003 A study of the efficacy of a thermostable Newcastle disease vaccine in village chickens when administered by different routes. *Workshop on Smallholder Poultry Development, University of Natal*, 29–30 October 2003
10. Chambers R 1992 Rapid and participatory rural appraisal. *Africanus* 22: 7–15
11. Chambers R 1994 *Paradigm shifts and the practice of participatory research and development*. IDS, London
12. Collinson M (ed.) 2000. *A history of farming systems research*. FAO/CABI, Rome
13. Intervet 2000. Nobilis ND Inkukhu vaccine, product specifications. URL <http://www.intervet.co.za/species/poultry.asp> (accessed September 2007)
14. McCrindle C M E, Tice G., Mogajane M E, Stewart C G, Mosupi H 1994 An investigation into the potential veterinary needs of a semi rural low-income community. *Journal of the South African Veterinary Association* 65(3): 90–96
15. Mogoje B L 2006 Application of thermostable Newcastle disease vaccine in free ranging chickens (in preparation).
16. OIE 2006 <http://www.oie.int> (accessed September 2006)
17. Röling N G, Wagemakers M A E (eds) 1998 *Facilitating sustainable agriculture*. Cambridge University Press, New York
18. Spradbrow P B, Samuel J L 1991 Oral Newcastle disease vaccination with V4 virus in chickens: comparisons with other routes. *Australian Veterinary Journal* 68(3): 114–115
19. Spradbrow P B 1992. A review of the use of food carriers for the delivery of oral Newcastle disease vaccine. In Spradbrow, P B (ed.), *Proceedings of an International Workshop, Kuala Lumpur*, 6–10 October 1991. *ACIAR Proceedings* No. 39, Canberra: 18–20
20. Spradbrow P B 2001 Thermostable Newcastle disease vaccine. In Alders R G, Spradbrow, P B *SADC Planning Workshop on Newcastle Disease Control in Village Chickens*. Proceedings of an international workshop held in Maputo, Mozambique, 6–9 March 2000. *ACIAR Proceedings* No. 103, Canberra: 61–66
21. Stats SA 2004 Online: <http://www.statssa.gov.za> (accessed September 2007)
22. Thekisoe M M O, Mbatia P A, Bisschop S P R 2004 Different approaches to the vaccination of free ranging village chickens against Newcastle disease in Qwa-Qwa, South Africa. *Veterinary Microbiology* June: 23–30
23. Tsibane T 2001 Country report: South Africa. In Alders R G, Spradbrow P B (eds) *SADC Planning Workshop on Newcastle Disease Control in Village Chickens*. Proceedings of an international workshop held in Maputo, Mozambique, 6–9 March 2000. *ACIAR Proceedings* No. 103, Canberra: 32–35