NEWCASTLE DISEASE IN VILLAGE CHICKENS

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INTRODUCTION

In many developing countries, chickens are the livestock most commonly owned by rural families. Many of these families have scarce resources and many may be headed by women. Increasing the productivity of their chickens would make a significant contribution towards increasing their food security and their ability to have secure livelihoods. Village chickens provide meat and eggs, food for special festivals, offerings for traditional ceremonies, pest control and petty cash to, for instance, purchase medicines or pay school fees (Alders and Spradbrow, 2001a).

Food security is achieved efficiently when people produce or have access to sufficient quantities of affordable, high quality food. It is generally acknowledged that poultry production is the most efficient and cost-effective way to increase the availability of high-protein food (FAO, 1987). Eggs can be stored under village conditions more easily than most foods of animal origin. For decades, the egg has represented the standard reference food, perfectly balanced, containing most essential amino acids, large amounts of calcium, phosphorus, magnesium, iron and zinc. It represents one of the main sources of vitamin A and of vitamin B complex. One egg provides approximately 11.5 percent of daily protein requirements and 5 percent of daily energy requirements (Branckaert *et al*., 2000).

Village chickens are also one of the few types of livestock that cause little impact on the environment and that require few inputs in order to yield a significant output in terms of meat and eggs (Alders and Spradbrow, 2001a). They are the livestock most likely to be owned and cared for by women and children (Guèye, 2000; Spradbrow 1993-94).

By common agreement of all but a very few of those who have studied village poultry, ND is the single greatest constraint on the production of village poultry (Alders and Spradbrow, 2001b; Alexander, 1988a, 2001; Kitalyi, 1998; Spradbrow, 1993-94). It is endemic in village poultry populations in Africa and Asia. Serological surveys indicate the presence of the virus in village poultry in countries throughout these continents, and where virus isolation has been attempted, virulent strains have been found (Spradbrow, 1993/94). ND can cause up to 100 percent mortality in susceptible populations during devastating outbreaks and sporadic losses throughout the year where the disease is endemic. In areas where ND is endemic, the disease is generally well-recognised by farmers and it discourages them from investing time and money in improving the standard of their poultry husbandry (Spradbrow, 1996). In such areas, control of ND will result in substantial increases in village chicken numbers (Alders and Spradbrow, 2001a, 2001b). However, where ND control has been undertaken as part of a development project, control activities have rarely continued after the end of the project. This lack of sustainability may have been due in part to the fact that projects concentrated on technical issues and paid little attention to social, cultural, administrative and economic issues such as community participation, gender sensitive extension activities, facilitation of government policies, training of staff and farmers, cost-recovery, and distribution and marketing networks. In many countries, rural families who keep village chickens will have had little contact with veterinary services and have

little contact with the formal economy. It is well-recognised that resource poor people are the least likely to take risks and, as a result, adopt new technologies only once they are sure of an adequate return on their investment of both time and money (AFFHC, 1987).

SPECIFIC EPIDEMIOLOGICAL CONSIDERATIONS FOR ND IN VILLAGE CHICKENS

Chicken production systems

Village chicken production is vastly different from that practised in the large-scale commercial poultry industry and the peri-urban semi-intensive poultry production found in many developing countries (see Table 4.1). The output of traditional village chickens in terms of weight gain and number of eggs per hen per year is low, but it is obtained with minimum input in terms of housing, disease control, management and supplementary feeding (Alders and Spradbrow, 2001a; Kitalyi, 1998). Village chickens may be provided with rudimentary housing and occasional supplementary feed. Flocks are usually small, containing 5-20 birds per household (Guèye, 1997) with all age groups represented (Alders and Spradbrow, 2001a). In Tanzania, the aver age ratio of chicks to growers to adults is 10:5:6 (Minga *et al*., 2001).

Table 4.1. Comparison of village, smallholder producer and commercial chicken flocks.

Criteria	Village flocks	Smallholder producer flocks	Commercial flocks
Flock size	Small	Medium	Large
Age	Mixed age	Single age	Single age
Housing	Trees, simple chicken houses used for overnight shelter	Built to house chickens constantly.	Large chicken units
Source of replacement stock	Natural incubation	Purchase of day old chicks	Artificial incubation or purchase of day old chicks
Feed source	Scavenging, Feed Resource Base, household scraps, cereals when available	Commercial balanced ration used when available, occasionally ration prepared from local feeds	Commercial balanced ration
Farming system	Integrated farming system involving extensive crop and livestock production	Usually single enterprise, intensive	Single enterprise, intensive
Veterinary inputs	None, vaccination against ND	Control of viral, bacterial and parasitic diseases essential for efficient production	Control of viral, bacterial and parasitic diseases essential for efficient production
Production	Low; could improve with better nutrition, disease control and shelter from predators	Moderate if all essential inputs available.	High; but requires a high level of inputs.
Access to urban markets	Limited	Moderate	Extensive
Genetic diversity	Extensive	Moderate to limited	Limited

Spread of disease in village chickens

The introduction of the ND virus to a village is most likely to occur when infected live chickens are introduced (Martin, 1992; Spradbrow, 1993-94). Live bird markets are often involved in the movement of the disease (Alexander, 1988b; Spradbrow, 1993-

94). Outbreaks of epizootic disease are readily noticed and occur in flocks where there are large numbers of birds susceptible to ND. Enzootic forms of ND that causes only occasional deaths may occur in village chickens (Alders and Spradbrow, 2001a).

Figure 2 These village poultry traders in Dakar, Senegal, sell birds (chickens, guinea fowl, ducks) that have been collected from many different farms and many different parts of the country.

The reservoir of ND virus in the typical village is not well understood and Martin (1992) states that the following factors can play a part, depending on the prevailing conditions in each village:

- **Cycling of infection within the village chicken population** - under village conditions, a ND outbreak can take weeks to pass through a flock and months to pass through a village.
- **Other domestic birds** - domestic birds such as ducks, doves, turkeys, geese, guinea fowl, etc. can harbour the ND virus. These birds can be infected with the virus and become a source of infection for chickens. They may or may not develop clinical ND, depending on the strain of virus and the bird species.
- **Carrier chickens** - It is uncertain whether chickens can become long-term carriers of the ND virus. However, ND vaccines may induce an immunity that

prevents clinical disease but that does not necessarily prevent ND. This means that chickens vaccinated against ND can become infected by virulent ND virus without developing clinical signs and then spread the virus to other birds.

- **Wild birds** - Strains of ND virus of varying virulence have been found in many species of wild birds (Alexander, 1988b), but the role of ND infected wild birds in the epidemiology of the disease in village chickens remains unclear.
- **The physical environment** - Infected birds shed virus in their faeces, where it can survive perhaps up to 3 months at temperatures of 20-30°C and longer at cooler temperatures.

CONTROLLING ND IN VILLAGE CHICKENS

Much has been written about ND and its control in the commercial poultry sector. Comparatively little literature is available on ND in the family sector although most authors agree that it is a major constraint to village chicken production (Sonaiya, 2000; Spradbrow, 1993-94). While the basic characteristics of the ND virus encountered in the commercial and family sectors are similar, it is the production systems used to raise village chickens and the socio-economic status of their owners that make ND control in the family sector a very complex issue.

The control of ND in the family sector, as in the commercial sector, requires a multifaceted approach. In the commercial sector, ND control consists of (Alexander, 1997):

- **International control policies** - details are available from the OIE (2001).
- **National control policies** - these vary from country to country and include eradication policies requiring the compulsory slaughter of infected birds, and obligatory vaccination of all birds. Higgins and Shortridge (1988) stress the importance of tailoring control policies to the country and warn against the dogmatic application of policies successful in one country to another which may differ socially, economically and climatically.
- **Biosecurity at the farm level** - a discussion of sanitation and security practices for commercial poultry units may be found elsewhere (Zander *et al*., 1997).
- **Vaccination** - Alexander (1997) emphasised that there are no circumstances in which vaccination can be regarded as an alternative to good management practice, biosecurity or good hygiene in rearing domestic poultry.

While the details may vary, in general, these four components also apply to the control of ND in the family sector. The challenge is to develop an effective ND control programme for the family sector that is sustainable, both economically and socially.

Animal Disease laws in most countries make no distinction between the commercial and family sectors. When such legislation is being revised, all sectors should be consulted to ensure that the legislation is relevant to the prevailing national conditions and that it will promote the improvement of livestock production through the effective control of disease (Sonaiya, 2001).

In countries where farmers are not compensated for the loss of their livestock, the quarantine and mandatory slaughter of affected birds ("stamping out") in the face of an ND outbreak will rarely be successful. In such circumstances, ND is more likely to be controlled in rural areas if farmers are encouraged to use husbandry practices that can limit the spread of the disease while salvaging some part of the affected birds (see Figure 3). Stringent Animal Disease laws can also contribute to the under-reporting of ND as farmers see no reason to report outbreaks to the government authorities (Tsibane, 2001).

Figure 3 This Mozambican village chicken farmer is providing moistened maize bran to her chickens that have ND. Some chickens that contract mesogenic strains of ND will recover and palliative care provided by owners improves the survival rate.

Compulsory vaccination against ND will meet with success only if the vaccine is offered free of charge. Even when free, an extension campaign will be required to assure farmers that the vaccine is safe and inform them how and when the vaccine should be administered. Where funding is limited, small-scale farmers must contribute to the cost of vaccination. In most cases farmers will place a higher value on the vaccine if they are required to purchase it and such payments will assist the overall sustainability of the ND control programme. Consequently, attention must be given to raising the awareness of farmers with regards to the prevention of ND by vaccination and ensuring that the vaccine used is efficacious, safe, appropriate to local conditions, available and affordable.

In order for the control of ND to make an ongoing contribution to the well-being of village chicken farmers and their families, the control activities must bring together the key stakeholders and they must fully appreciate the complexity of the exercise that they are about to commence. In areas where a cold chain is lacking, the use of thermostable ND vaccine will make the vaccination of chickens possible. These same areas will

frequently be characterised by a lack of infrastructure in general and limited human resource capacity. Therefore the vaccination and improved husbandry of chickens must be accompanied by appropriate organisational, training, communication and economic practices.

Experience has shown that a sustainable ND control programme has four essential components (Alders *et al*., 2001b):

- an appropriate vaccine and vaccine technology;
- effective extension materials and methodologies that target veterinary and extension staff as well as community vaccinators and farmers;
- simple evaluation and monitoring systems of both technical and socio-economic indicators;
- economic sustainability based on the commercialisation of the vaccine and vaccination services and the marketing of surplus chickens and eggs.

Organisation

Farmers, extension workers, veterinary services staff, private business people (including chicken traders), livestock and social scientists and non-governmental organisations (NGOs) are the stakeholders who should be involved in ND control activities from the outset (Alders, 2001). All stakeholders must work together to ensure that a suitable vaccine is available in the field at the required time, that the users of the vaccine have received sufficient training to enable them to use it with success, that the costs associated with the production (or importation) of the vaccine are covered and that the ND control activities are monitored. These activities will be implemented with greater ease if the relevant national and provincial government agencies are supportive and create an enabling policy environment, particularly with regard to cost-recovery.

As with all endeavours, it is best to start small and build on each success. In most cases, farmers will be expected to pay for the ND vaccine and so it is critical that the first vaccination be successful. Most farmers will not want to try a second time. The best way of ensuring good results is to prepare thoroughly before commencing with vaccinations in the field and to have the will and the resources to ensure that subsequent campaigns are implemented at the recommended intervals. (Alders and Spradbrow, 2001a)

Community Participation

The farmers are the clients of any ND control programme and the programme should be designed to meet their needs and expectations. Farmer participation is usually not achieved easily. Farmers communicate more easily with people who display knowledge and understanding of the local farming system and who are willing to spend quality time with them. It is essential that the priorities and knowledge of farmers be respected (Alders, 1998). All activities should be discussed and then presented to representative groups of farmers.

In addition, it is essential that farmers should not be seen as a homogeneous group. Demographic studies should be done to determine the various groups involved with village chicken production, and care should be taken to ensure that each of the key groups is given a chance to contribute to the discussion. Groups may vary according to gender, age, religion, wealth status, ethnicity or role in the production system.

The various roles in the production system should be investigated. Roles will vary within households. Who will administer the vaccine to village chickens? Some farmers will become community vaccinators or community livestock workers - CLWs (these workers will receive wider training and be able to treat a range of livestock diseases). Who will be involved in the distribution of the ND vaccine - government agencies or private traders? Village chicken traders are often neglected in ND control activities but they also suffer huge financial losses due to ND, particularly when traders travel long distances and are forced to keep birds from different flocks together for several days prior to sale.

In many cases, NGOs will be well-placed to facilitate connections between communities and government agencies. In areas where the private sector is not well developed, government agencies will need to facilitate farmer access to the vaccine.

Coordination between Government Services

Many countries are currently moving towards a unified agricultural extension service. This process is often not without difficulties and every attempt should be made to ensure that those with relevant experience and responsibility within the extension services and the veterinary services are able to contribute.

If Government services are involved in the distribution of the vaccine, then it is useful if representatives of the relevant administrative sections are invited to assist with the development of a robust cost-recovery and accounting system.

Links should also be established with the Ministries of Education and Health. Appropriate extension packages on the control of ND in village chickens can be designed for use in primary schools and human nutrition and literacy programmes.

Co-ordination between Government, the Private Sector and NGOs

The privatisation of veterinary services is being promoted in many countries. In the case of the control of ND in village chickens, it is doubtful whether the local production of ND vaccine or its administration in the field would generate sufficient profit to make it attractive to private companies, veterinarians or animal husbandry experts (Alders, 2001). To ensure a supply of ND vaccine of suitable quality for the family sector, it may be best to consider the commercialisation of vaccine production in appropriate government laboratories in the short term. With regard to administration and distribution, village chicken farmers can be trained as community vaccinators and governments must decide whether to allow the sale of ND vaccines by private operators. In each case, governments will have to assume responsibility for the supervision of community

vaccinators and private operators to ensure that the quality of services and vaccine being provided is acceptable. NGOs often support disease control activities in rural areas and it is essential that the approach used conforms to government policy and can be readily integrated into government and private sector activities at the end of the project.

The recommendations above require ongoing government involvement in ND control activities in the short to medium term (Alders, 2000). This involvement can be considered a "public good" as the improved household production of village chickens will:

- **Improve household food security** - increased protein intake by children will decrease malnutrition and enable their mental capabilities to develop to their full potential (Pinstrup-Andersen, *et al*., 1993) thus ensuring a more productive working life.
- **Improve household income** - increased sales of chickens will enable families to resolve other problems such as the need for medicines, school fees, etc.
- **Increase access to chickens in urban and peri-urban areas** - once chicken traders identify areas where ND vaccination takes place regularly, they will choose to trade with chicken farmers in that location. If mortalities among purchased chickens decrease and the number of chickens available for purchase increases, the unit sale price of chickens should decrease. Consequently, the number of urban consumers who can afford to purchase chickens will increase.

Communication

With the introduction of a new intervention, all involved with the work should receive information appropriate to their role to enable them to make sound decisions that will support the successful implementation of activities (Alders, 2001). In the case of ND control in village chickens, information packages should be prepared for every link in the chain between the production of the vaccine and the chicken that is to be vaccinated. Senior national and international decision makers require concise information concerning the benefits to be gained from the control of ND in village chickens and the policies required to facilitate the sustainable implementation of control activities. Extension workers, veterinarians and project managers need detailed information to help them design, implement, monitor and evaluate ND control activities. Provincial and district staff benefit from practical guides to the implementation and supervision of field activities. In many cases, farmers must initially be informed of the existence of ND vaccines, be convinced of their efficacy and then provided with appropriate training to enable them to benefit from the technology.

Data collection

Livestock disease control activities generally commence with the collection of data concerning the status of the disease and the livestock population at risk. A number of farmer questionnaires have been developed which focus on ND and village chicken

production (see Alders and Spradbrow, 2001a; IAEA 1999; Kitalyi, 1998). In order to better target the communication packages, information should also be gathered to enable the construction of a demographic profile of farmers and the educational level and experience of staff to be involved.

Agricultural Extension

A comprehensive extension package should be developed for use with all available communication options, in particular, radio, newspapers, group meetings, field days, drama, and school lessons. Such a package has been developed in Mozambique and is available for adaptation for use in other countries.

Where literacy levels are low, more attention should be given to audiovisual and non-formal means of communication. Adequate time and resources must be invested in the development and evaluation of the extension material. The effectiveness of the extension material is critical in situations where farmers are to pay for the vaccine.

Participatory techniques

Participatory methodologies provide a wide range of information and help to focus attention on those aspects most important to farmers. These methodologies may assist with situation analyses from the farmers' point of view, the collection of ethnoveterinary knowledge and participatory technology development. Care must be taken to ensure that participatory techniques are used in a gender-sensitive manner. Regular analyses of farmers' perception of the ND control programme should be conducted and should take into account other household activities. Participatory methodologies that can improve our understanding of village poultry farmers and village poultry production have been discussed elsewhere (Alders and Spradbrow, 2001a).

The frontline extension staff must be encouraged to accompany the ND control activities and identify other constraints that limit poultry production. Extensionists should work with farmers in a process of continuous improvement using approaches that facilitate adult learning (Klatt, 1999; Van Veldhuizen *et al*., 1997). This process will also assist with effective evaluation and monitoring of ND control activities.

Gender issues

Gender is defined as the socially determined differences between women and men, as opposed to the word "sex" which denotes physical differences. Gender differences are historically determined, culturally specific and dynamic. They define how women and men interact in a specific context, and what is considered appropriate for women and men to do, thus determining their respective development options and constraints (Gujit, 1994).

Experiences to date show that participatory techniques are not automatically gender-sensitive (Guijt, 1994). Those using participatory methods in the field carry with them

personal biases, experiences and agendas, all of which shape the final analysis. Therefore, without gender-sensitive field workers, gender issues are not likely to be raised.

To improve village chicken production, it is necessary to learn who does what and then help them do it better. Collecting gender-disaggregated data helps to determine how the tasks associated with village poultry production are divided within households (Alders and Spradbrow, 2001a). It is well-known that direct communication with the person who actually does the work is more effective.

Clear consistent messages

With regards to the vaccination of family chickens in particular, extension messages must be simple, clear and consistent (Bagnol, 2000).

Pre-testing of extension material

It is vital that new extension material be pre-tested in the field prior to widespread diffusion to ensure that it will effectively communicate the desired message(s) to farmers. Pre-testing does cost money but it can be done in relatively simple and inexpensive ways. The amount is insignificant compared to the actual production costs and money can be saved by avoiding the production of materials that are not understood or accepted. (Bertrand, 1978; Dudley and Haaland, 1993; Haaland, 1984; Zimmerman *et al*., 1996).

Since women have had less access to Western means of communication and often have more difficulty than men in interpreting material presented in Western ways, it is essential that extension material is specifically pre-tested with both male and female farmers (Alders and Bagnol, 2000).

Training

Better results will be achieved if relevant training is provided for all involved in ND control. Seminars and short courses for key national and provincial decision makers will help to familiarise people with concepts and assist in bringing people together as a team. Workshops for staff involved in the training of extension workers and community vaccinators should include both theoretical and practical sessions to ensure that the trainers understand and appreciate the work to be undertaken in the field. Trainees should understand the key principles of adult education and how they differ from approaches commonly used to teach children in schools (Klatt, 1999).

The training programme for extension workers and community vaccinators should include both training sessions and refresher courses. Components of the training should include the characteristics, handling and administration of the chosen vaccine, how to organise a vaccination campaign and how to monitor progress (see Alders and Spradbrow, 2001a; Alders *et al*., 2001a). In the early stages of the ND control

programme, the refresher courses provide an opportunity for trainers to get feedback from the field on how the training can be improved.

While vaccines may be the method of choice for controlling ND in village chickens, training packages for field personnel should include information on general husbandry practices that assist with the prevention of disease. Good husbandry will reduce the impact of other diseases and predation while improving production through strategic supplementary feeding.

Vaccination

Vaccine Selection

The selection of a ND vaccine for use in family poultry will depend on the local conditions in each country. Selection criteria will include:

- Ease of use
- Thermostability (where the cold chain is non-existent or unreliable)
- Cost
- Immunogenicity
- Transportability
- Availability

In circumstances where the cold chain is weak or absent, the only reliable option may be the use of thermostable ND vaccines; i.e. the live vaccines NDV4-HR (Ideris *et al*., 1987) and I-2 (Bensink and Spradbrow, 1999), or inactivated vaccines. In most cases, farmers contribute wholly or partially to the cost of the vaccine and the price of the vaccine is therefore a major factor. The lower the price of the vaccine, the greater will be the number of farmers able to afford it and, consequently, the greater the vaccination coverage. The lowest cost thermostable ND vaccine is generally produced locally I-2 "wet" vaccine. Locally produced freeze-dried I-2 ND vaccine is usually cheaper than imported freeze-dried live and inactivated vaccines, but more expensive than the "wet" vaccine. The freeze-drying process, the special vials, caps and labels all increase the cost of the vaccine. However, freeze-dried vaccine does have a longer shelf life than "wet" vaccine.

To facilitate the vaccine selection process, it is advisable to conduct a risk assessment of the options available. The risk assessment will also form part of the vaccine registration process. This assessment should be done in sufficient detail for all stakeholders to understand the risks and benefits associated with each option. The economic implication of each option should also be determined. The assessment will require more time and investigation in countries that choose to produce the ND vaccine locally.

Local production

ND vaccine of a quality acceptable for use in village chickens can be produced in the laboratories of some developing countries (Alders *et al*., 2000; Buza and Mwamuhehe 2001; Dias *et al*., 2001; Tu, 2001). In these cases, the vaccine is produced in eggs which are not specific-pathogen-free (SPF), but which come from healthy flocks that are screened for key poultry diseases (such as pullorum disease) that can be transmitted through eggs.

In countries where ND is endemic, the high mortalities associated with ND outbreaks will most likely indicate that the risks of not controlling the disease are far greater than the possible risks associated with using a ND vaccine that is locally produced. The lower price of the locally produced vaccine (particularly the "wet" I-2 vaccine) will increase the number of birds that can be vaccinated with the funds available. In addition, locally produced vaccine requires less foreign exchange.

Where funding is not limited, it is best to use SPF eggs or high quality minimal disease flock (MDF) eggs. However, it is unlikely that freeze-dried ND vaccine produced locally in imported SPF eggs would be cheaper than that produced by the two commercial companies currently producing the NDV4-HR vaccine. However, this is true only if foreign exchange issues are not a limitation (Alders and Spradbrow 2001a). There may be a cost advantage if SPF eggs are used to produce "wet" vaccine.

Quality control of vaccine

It is vital that the vaccine used in the field be efficacious. Veterinary Authorities should verify that the vaccine being used is of appropriate quality to ensure that chickens will be protected against ND with a minimal risk of other complications. Whether vaccine is produced locally or imported, each batch should be tested to confirm that the vaccine has an adequate titre of ND virus. The titre of live ND vaccines can be determined via titration in embryonated eggs. It is not possible to determine the titre of inactivated vaccines, but an estimate of potency can be determined by monitoring antibody response to vaccination in chickens. Certification that the vaccine is free of key poultry pathogens that can be transmitted vertically should be sought.

Live, thermostable ND vaccines

A thermostable vaccine enables distributors and users to reduce the problems associated with inadequate cold chains in the field. It is essential that users understand that a thermostable vaccine must still be treated with some of the respect due to a biological product, for example, the vaccine cannot be exposed to sunlight or frequent shifts in temperature and still be expected to remain active. (Alders and Spradbrow, 2001a)

NDV4-HR vaccine

The heat resistant V4 (NDV4-HR) vaccine against ND has yielded encouraging results in many countries in Africa (Alders and Spradbrow, 2001a) and Southeast Asia (Spradbrow, 1993-94).

NDV4-HR vaccine is a living vaccine with the following characteristics:

- it is thermostable, retaining its activity for 12 weeks at a temperature of 28°C in freeze-dried form (Ideris *et al*., 1987);
- it can be administered via eye-drop (intraocular), nose-drop (intranasal), oral drench, or drinking water; mixed with certain feeds or by injection (Spradbrow, 1993-94; Anon, 1991);
- its ease of administration makes it suitable for use by village farmers;
- the vaccine strain can be transmitted by contact from vaccinated to non-vaccinated birds (Alders *et al*., 1994; Spradbrow, 1993-94)
- it is avirulent and can be safely administered to chickens of any age from day-old chicks to adult birds (Spradbrow, 1993-94; Anon, 1991)
- its biological safety is superior to that of other living ND vaccine strains such as B1 or La Sota (Anon, 1991).

ND I-2 vaccine

The Australian Centre for International Agricultural Research (ACIAR) commissioned workers at the Virus Laboratory in the University of Queensland to produce a seed virus similar to NDV4-HR that could be made available without cost to laboratories in developing countries (Bensink and Spradbrow, 1999). Forty-five isolates of avirulent ND were examined for antigenicity, safety and ability to spread. The most promising of these isolates were checked for their thermostability and the more resistant isolates selected for enhanced heat resistance. The result was strain I-2, which was amplified in eggs from a disease-free flock to form a master seed. The seed was tested for safety and for freedom from bacterial contamination.

Strain I-2 has undergone laboratory tests in several countries and has proved to be protective against local virulent strains of the ND virus (Alders and Spradbrow, 2001b). In Vietnam, after extensive laboratory and village trials, it has been officially recognised as the ND vaccine for village chickens (Tu *et al*., 1998). In Tanzania, it has given protection for at least two months after vaccination (Wambura *et al*., 2000). Field records in Mozambique indicate that I-2 ND vaccine provides approximately 80 percent protection in the field in the face of an outbreak, when given every four months via eye-drop (Alders and Spradbrow, 2001a).

ND vaccine of acceptable standard can be produced from strain I-2 in central laboratories or even regional laboratories in developing countries. The vaccine can be produced in eggs which are not specifically pathogen-free, but which come from a flock that is regularly screened for key poultry diseases. It can be produced and stored in

liquid form, and suitably diluted in a protective solution such as 1 percent gelatin (in which the vaccine will maintain its activity for at least twelve weeks at 22°C; Bensink and Spradbrow, 1999) before use. The thermostable vaccine is then best administered via eye-drop. The I-2 vaccine produced in Mozambique will retain its activity for eight weeks at 28°C when freeze-dried and stored in the dark.

Storage and transport conditions for thermostable ND vaccines

If users have access to normal cold chain facilities, these should be used, even when dealing with a thermostable vaccine. Freeze-dried vaccine stored at 4-8°C will retain high titre for a longer period than that stored at ambient temperature. At 4-8°C, the vaccine should maintain an adequate titre for at least one year.

When taking the vaccine to the field, it should be placed in a cool box with ice or an ice pack. The vaccine should not be frozen (unless the instructions specifically indicate that it may be frozen). Freeze-dried vaccine packaged under vacuum rather than with nitrogen will lose the vacuum and gain moisture if the vial is frozen. The rubber cap on the vial contracts when frozen, enabling moist air to enter the vial. When this occurs, the shelf life of the vaccine is reduced.

These vaccines are thermostable, but attention to the conservation of the vaccine once removed from refrigeration will ensure optimal results:

- The vaccine should always be kept away from sunlight.
- When transporting the vaccine in the field, it should be wrapped in a damp cloth and carried in a covered open-weave basket. This allows evaporative cooling which helps to keep the vaccine cool and the cover prevents contact with sunlight.
- The date the vaccine leaves the cold chain should be recorded as it will remain effective for 2-3 months only.
- The vaccine should be stored in a cool, dark location, for example, near the base of a clay water pot.

Administration of thermostable ND vaccines

Standard dose - As with other live ND vaccines such as La Sota, a minimum of 10^6 EID_{50}/bird is required to produce an adequate level of protection. EID_{50} (50 percent embryo infectious dose) is a laboratory measure of the content of living infectious virus in a vaccine. It has been demonstrated that birds that received a higher oral dose of the NDV4-HR vaccine generated a higher immune response when confined in cages with wire floors (Spradbrow *et al*., 1988). This means that even though the thermostable vaccine can survive at ambient temperatures, attempts to improve its conservation will result in a slightly higher vaccine titre at the time of vaccination and consequently a higher and longer-lasting immunity. This is particularly important when birds are not housed together at night.

Administration route - These vaccines can be administered via eye-drop, drinking water, certain feeds and injection. Field trials in Mozambique indicated that almost all farmers preferred eye-drop administration even though it entails the capture of birds. In their opinion, eye-drop administration produces a greater survival rate, has a lower frequency of administration and is easy. It is important that the eye-dropper used be made of virus-friendly plastic and that it is calibrated to ensure that one drop contains one dose. Calibration of the eye-dropper and administration of the eye-drop to the bird is done with the dropper in a vertical position to make sure that drops of a uniform size are produced.

Age of bird - The same dose is given to birds of all ages, from day-old chicks to adults.

Vaccination schedule - For eye-drop administration, the vaccine should be administered once, with re-vaccination every 3-4 months. Via drinking water, the vaccine should initially be given on two occasions, 2-3 weeks apart, with re-vaccination at least every three months.

Dilution and use of thermostable ND vaccines

These vaccines may be diluted using locally available potable water. It is recommended that the water is boiled and left to cool overnight in a non-metallic container before use.

Chlorinated tap water is unsuitable. If, however, this is the only water available, the treated tap water should stand overnight to allow the chlorine to dissipate or one teaspoon of powdered milk per 10 litres of water should be added to neutralise the effects of the chlorine.

Once the freeze-dried vaccine has been diluted, it is advisable to follow these simple rules for eye-drop administration:

Day 1 1 drop per bird (i.e. on the first day of the vaccination campaign).
Day 2 2 drops per bird
Day 3 discard

Horizontal spread of thermostable live ND vaccine virus

The thermostable live ND vaccines spread from vaccinated to unvaccinated birds when they are housed together (Alders *et al*., 1994; Bensink and Spradbrow, 1999; Tu *et al*. 1998, Spradbrow, 1993-94). The degree of spread under field conditions is less when birds roost in trees and horizontal transmission should not be seen as a reliable substitute for vaccinating village birds.

Safety issues

The avirulent live ND vaccines such as I-2 and NDV4-HR are considered to be harmless to birds. Both the I-2 and NDV4-HR vaccines produce no evidence of clinical

respiratory signs, weight loss, mortality in young chickens or egg production drop after vaccination (Bensink and Spradbrow, 1999; Heath *et al*., 1992). The safety performance of original V4 (avirulent) vaccine is superior to both the HB1 (lentogenic) and La Sota (mesogenic) vaccine strains (Table 4.2).

Genetic sequencing of thermostable live ND vaccines

Genetic analysis indicates a relationship between the chemical structure of surface proteins of limited areas of the genome of strains of ND virus and the virulence of these strains. An area of apparent importance is the cleavage site of the fusion protein on the surface of the virus particle. Particular amino acid patterns around the cleavage site in virulent strains have become known as the virulence sequence. V4 and I-2 and other vaccines such as La Sota and HB1 lack the virulence sequence (Alders and Spradbrow, 2001a).

Table 4.2. Comparative safety of Newcastle disease vaccine strains (Heath *et al*., 1992).

Signs in vaccinated birds	Vaccine strain		
	V4	HB1	La Sota
Sneeze test	Nil	Definite signs	Pronounced signs
Respiratory disease	Nil	Clinical respiratory signs	Clinical respiratory signs
Weight gain	No effect	Significant reduction	Highly significant suppression
Mortality in young chickens	Nil	Yes	Yes
Egg production drop	Nil	5-10 %	>10 %

Live partially thermostable ND vaccine

Nobilis ND Inkukhu is not a thermostable vaccine in the true sense of the word; it is a freeze-dried vaccine that is stable in freeze-dried form for up to seven days in temperatures not exceeding 30°C. At such temperatures the infectivity titre remains stable for seven days. (Alders and Spradbrow, 2001)

Once reconstituted with a diluent, it should be treated as any standard freeze-dried ND vaccine, i.e. on dilution, the vaccine should be used within one hour. Furthermore, once removed from refrigeration for an extended period, it must be used within the seven-day period and not returned to refrigeration for further storage. The expiry date printed on each vial is valid only when the vaccine is kept constantly under refrigeration.

This product is distributed in South Africa by Intervet and is aimed primarily at the small-scale commercial farmer in outlying areas. It offers this type of farmer the ease of transporting the vaccine from the supplier (with refrigeration) to his/her farm (which

often has no refrigeration) without the cold chain required for conventional freeze-dried vaccines.

The vaccine strain is ND Clone LZ.58, originally marketed by Mycopharm in the Delvax range. The vaccine Delvax ND Clone LZ.58 has proven its efficacy in numerous poultry producing countries as a primer and booster vaccine against ND. It is a clone of the Hitchener strain and will induce some post- vaccinal reactions in chickens. Post-vaccinal reactions occur during the first week following vaccination and include a mild snick and a very slight rise in mortality (less than 0.2 percent).

Inactivated thermostable ND vaccine

Inactivated oil emulsion ND vaccines are less heat sensitive than the conventional live ND vaccines, making their transport to villages more feasible (Bell, 2001).

These vaccines must be injected and the volume injected varies according to the age of the bird. One manufacturer has stated that their inactivated ND vaccine will maintain its activity for several days at temperatures of 15-25°C (LAPROVET, 1992). These vaccines must not be frozen. Prior to use, the vaccine must be slowly brought to room temperature and shaken well to ensure that the emulsion is fluid and the contents are evenly distributed.

Although inactivated vaccine gives good protection (the standard re-vaccination interval is six months), it is relatively expensive to produce (Alexander, 2000; Bell, 2001; Cessi and Nardelli 1974). Quality control of inactivated vaccine is often difficult, and mineral oils may cause serious problems to the vaccinator if accidentally injected (Alexander, 1997). Adverse reactions to inactivated vaccine post-vaccination are rare (Alexander, 1997).

Inactivated ND vaccines have been used successfully in village chickens, for example, in West Africa (Rémond and Quinet, 2000; Verger, 1986).

Live mesogenic ND vaccines

Mesogenic live vaccines tend to be used in countries where virulent NDV is widespread and maintenance of high antibody titres is important to prevent serious disease (Alexander, 2000). Mesogenic live vaccines can cause very severe post-vaccinal reactions and are pathogenic for birds less than eight weeks of age (Meulemans, 1988). The use of this type of vaccine is not recommended in circumstances where chickens do not have sufficient immune protection against the virus, on account of post-vaccinal reactions (Bell, 2001).

These vaccines are administered by injection after a primary vaccination with an apathogenic or lentogenic ND vaccine. In Asia, the strain most commonly used is Mukteswar, with the Komarov strain being more commonly used in some countries in Africa.

These vaccines are sufficiently virulent to fall within the new OIE definition of ND (Alexander, 2000).

Distribution of vaccine

A distribution system, ensuring the availability of the vaccine when farmers need it and also enabling payment for the vaccine to be returned to the producing or importing agency, is a major challenge in situations where the cold chain does not extend far into the field (Alders, 2001). In such situations, it is best to consider conducting ND vaccination campaigns. Campaigns should be carried out during specific months of the year and every effort should be made to ensure that the vaccine is available locally in the period immediately prior to the start of the campaign. For instance, in Mozambique, it is recommended that the I-2 ND vaccine should be administered by means of eye-drop in March, July and November. It is a major task to ensure that the freeze-dried I-2 vaccine (which cannot go without refrigeration for longer than two months), is available at the district level in the month prior to the campaigns. In areas where projects are being implemented, it is very tempting to rely on project staff to bring the vaccine into the area at agreed times. However, when the project ends, the supply of vaccine ends as well. Although more time consuming initially, it is important that options for the sustainable distribution of vaccine should be pursued in the field at the same time that ND vaccination commences. People who travel regularly from towns to the villages are the chicken traders. Would it be feasible for them to take the vaccine to the villages?

Where the cold chain is only lacking at the level of the farmers' household, the ND vaccine may be held in stock locally and purchased by farmers and vaccinators as required. The cold chain may be provided by veterinary services, human health services or the private sector. If farmers in ND endemic areas are able to vaccinate their flocks four times a year rather than the three times as is recommended in Mozambique (mainly for logistical reasons), then losses of chicks hatched between ND vaccination campaigns will decrease.

Distribution of the ND vaccine by government agencies or by private pharmacies requires supervision. A system that allows samples of vaccine to be sent back to central laboratories for periodic testing to confirm that it still contains an adequate titre, is recommended. Once the existence of a thermostable vaccine against ND becomes well-known, counterfeit vaccine may appear in local markets. Vaccine labels should be distinctive and users and suppliers must be encouraged to report counterfeit products to authorities.

Community Vaccinators

The person to administer the vaccine to the village chickens needs to be chosen carefully. In many cases, the most cost efficient option is the farmer or a community vaccinator. This option not only decreases costs, but also contributes to the increase of knowledge and expertise of the farmers.

The selection of community vaccinators will be critical to the success of the control programme. Vaccinators must be chosen and respected by the community that they are to serve. However, the vaccination of chickens alone will not be sufficiently lucrative for vaccinators who have no other means of income. It has been observed that vaccinators who raise chickens themselves are most likely to be successful community vaccinators as the protection of their own chickens is of economic benefit to them. The income gained from vaccinating the chickens of others with the remaining vaccine is an additional benefit, but not a substantial one in most countries.

While it is essential that women should be involved in the ND control activities, it is not always beneficial to train only women as community vaccinators. For vaccinators to be effective, they must be able to travel without encountering problems in buying and administering the vaccine. Travelling away from home can sometimes be difficult for women. Giving preference to women to be trained as vaccinators is commendable, however, other selection criteria must also be considered to ensure that the people selected will perform effectively. It is recommended that a community vaccinator should be:

- respected by the community.
- able to work with both male and female farmers and different groups within the community.
- able to travel the distances required to purchase vaccine and vaccinate chickens.
- able to read, write and do basic calculations.
- a village chicken farmer - protecting his/her own chickens from ND - will provide the community vaccinator with a substantial economic incentive. (Alders, *et al*., 2001a).

Developing and implementing ND vaccination campaigns

In most cases, farmers will be expected to pay for the ND vaccine, so it is critical that the first vaccination campaign is a success (Alders and Spradbrow, 2001a). Most farmers will not try a second time. The best way of ensuring good results is to prepare thoroughly before commencing with vaccinations in the field and to have the will and the resources to ensure that subsequent campaigns will be implemented at the recommended intervals.

Situation analysis

- **Awareness of officials, veterinarians and extension workers**

  Is the control of ND in village chickens seen as a priority by decision makers? What information do they need to help them understand the importance of vaccinating regularly against ND? Will existing government policies (on cost recovery, for instance) facilitate the development of a sustainable ND control programme?

- **Farmer awareness**

  Is ND a priority for farmers in the area where you plan to vaccinate? Do they know that a vaccine against ND exists?

- **Village chicken population**

  Obtain an estimate of village chicken numbers and, if farmers are to pay for the vaccine, make an estimate of the percentage of farmers likely to do so. This will enable you to order an appropriate quantity of vaccine.

- **Training requirements**

  Even if you plan to use a thermostable ND vaccine, it will not compensate for poorly trained personnel. For good results, make sure that all participants in the vaccination campaign have received the appropriate training. Training will vary according to the function of the individual:

  - veterinary services staff
  - extension staff
  - community livestock workers or community vaccinators

- **Seasonality of ND outbreaks**

  When are ND outbreaks most likely to occur? If a seasonal pattern to outbreaks is suspected, ensure that the campaign starts at least one month before the outbreaks are expected.

- **Agricultural and climatic calendar**

  Plan campaigns to coincide with those times of the year when farmers are not very busy in their fields and access to the area is possible.

- **Gender analysis**

  The campaigns will meet with better success if arrangements are made with the person in the family who owns and cares for the chickens.

- **Cost-recovery options**

  The majority of farmers are willing to pay for a product if they believe they will get a good return on their investment. Discuss payment options with the farmers and always give them advance notice so that they can arrange funds prior to the campaign.

- **Inputs**

  Always make sure that you know where you can get the supplies necessary for the vaccination campaign and that the material is in stock:

  - vaccine, of appropriate quality and quantity;

  - eye-droppers (see Alders and Spradbrow, 2001a for a description of suitable eye-droppers);

  - field allowances, etc. Even if you plan to work with CLWs, you will need to train and supervise them. These activities require funds and these funds must be confirmed before you begin your activities in the field.

Preparatory phase

- **Appropriate extension materials**

  Prepare, pre-test and duplicate the necessary extension material.

- **Training of personnel**

  Train personnel well in advance of the campaign. They need time to go back to their respective areas to raise farmer awareness, collect information and make their own preparations.

- **Timing of campaign**

  Decide in consultation with the staff, CLWs and farmers. Consider weather conditions, the farmers' annual work plan and the pattern of ND outbreaks.

- **Extension activities**

  Start at least one month prior to the campaign.

- **Vaccine administration options**

  Use eye-drop administration whenever possible when using live ND vaccine. However, in certain circumstances farmers may opt for oral administration. Consider whether the vaccinator is to travel to individual houses or if farmers should bring their birds to pre-arranged points.

- **Inputs**

  Vaccine, eye-droppers and syringes, per diems, transport, registration books, cool boxes or baskets and cloth must be procured.

Recommendations for ND vaccination campaigns

- Commence campaigns at least one month prior to the season when ND outbreaks are more common.
- Postpone the vaccination campaign if it is suspected that an outbreak of ND is in progress.
- Vaccinate healthy chickens only.
- Always inform farmers of the need to revaccinate their birds.
- Campaigns are best held during the weekends or school holidays.
- Cost-recovery, at least partial, is essential
- Never promise a 100 percent protection of chickens.
- Emphasise that the vaccine protects against ND only.

Implementation

On the first day of the vaccination campaign, you will have:

- trained teams;
- vaccine and other inputs;
- decided, in coordination with farmers, the site of vaccination:

    - house-to-house visits; or
    - central vaccination points;

- participating farmers registered;
- a way of identifying vaccinated chickens;
- a system in place for the vaccinator to register the number of birds vaccinated and payment received.

Economic sustainability

Cost-Recovery

For ND control activities to be sustainable in the long term, all costs associated with the production (or importation), distribution and use of the vaccine must be covered. In some instances, village chicken farmers may be expected to pay all of the costs. In many cases, government agencies may subsidise some aspects of the control activities with the remainder being paid for by farmers.

Cost Minimization

While not recommended, some governments or projects may wish to provide inputs such as ND vaccine free of charge. In such circumstances, the emphasis needs to be on cost minimization rather than cost recovery. The main costs associated with the control of ND using locally produced vaccine are: production costs, distribution costs and administration costs. With the production of freeze-dried vaccine, there must be a

trade off between the most cost-efficient number of doses of vaccine per vial and the number of doses that can realistically be used per day in the field. Where "wet" vaccine is produced, thought should be given to the most cost-efficient type of vials to be used to store and transport the vaccine. Community vaccinators or CLWs are likely to be the most cost-efficient means of administering the vaccine at village level.

It is advisable to consider a number of cost-minimization issues when producing vaccine locally. These issues include:

- the number of vaccination campaigns per year;
- the optimal number of doses per vial;
- the quality of eggs used to produce the vaccine;
- the quality of labels and leaflets produced to accompany the vaccine;
- conservation of the vaccine during transport; and
- conservation of vaccine in storage.

Number of vaccination campaigns per year

It is generally not possible to predict when an outbreak of ND will occur. ND vaccination schedules should be developed to ensure that most chickens have protective antibody titres throughout the year.

Field studies have shown that where ND is endemic, vaccination campaigns that promote the administration of single eye-drop of live ND vaccine every 3-4 months (without a booster vaccination after 2-3 weeks as occurs in the commercial sector), provides adequate protection (Bell *et al*., 1995; Dias *et al*., 2001). When inactivated vaccines are used, these should be administered every six months.

The number of doses of vaccine per vial is an important issue to consider when using freeze-dried vaccine (Alders *et al*., 2001a). Most rural families keep only a small number of chickens and would like to buy the vaccine in small doses. Unfortunately, it is not possible to produce vials of freeze-dried vaccine containing a small number of doses at low cost.. Most of the costs in the production of freeze-dried vaccine are for the vial, the metal cap, the rubber stopper and the label. The vaccine itself is relatively inexpensive. Consequently, the price per dose increases as the number of doses per vial decreases. For example:

Number of doses per vial	Cost price per vial (USD)	Cost price per dose (USD)
100 doses	USD 1.05	USD 0.0105
250 doses	USD 1.25	USD 0.0050
1000 doses	USD 1.50	USD 0.0015

In Mozambique, community vaccinators have managed to vaccinate up to 300 birds in one day. Consequently, a vial containing 250 doses was produced to enable the

vaccinators to use one vial per day with a cost price per dose of approximately USD 0.005.

Quality of eggs used to produce the vaccine

Fertile eggs are used to produce I-2 vaccine and the cost of these eggs contributes to the overall cost of vaccine production. Where funding is not limited, it is best to use specific pathogen-free (SPF) eggs. However, SPF eggs are expensive to produce or purchase, and problems with embryo viability have been reported (Allan *et al*., 1978).

In many countries the cost of ND vaccine production or importation will be borne by the end user of the vaccine - the owners of small flocks of village chickens who live in rural areas. The price of the vaccine will have a great influence on the number of smallholder farmers able to purchase the vaccine. It is important that those considering the local production of I-2 vaccine for use in village chickens weigh the risks of using an affordable vaccine of acceptable quality produced in MDF eggs against the losses farmers will experience when ND is not controlled because a vaccine produced in SPF eggs is too expensive for them to purchase.

Quality of vaccine labels and leaflets

In order to reduce production costs, it is recommended that all printed material be produced in black and white. Black and white material also yields better quality photocopies and so facilitates the copying of original material in the field.

Conservation of the vaccine during transport

The amount of time that the vaccine can be conserved in the field will depend on the integrity of the cold chain. Where the cold chain is unreliable or absent, the vaccine should only leave the cold chain when it is to be used within a short period of time.

The quality of materials used will depend on how quickly the vaccine will be used in the field. The manufacturing laboratory should provide adequate information to help buyers to conserve the vaccine appropriately. Thermostability trials should be used to determine how long the vaccine will retain its activities at various ambient temperatures. Data loggers can be used to study temperatures encountered by vaccine during transport and storage in the field under a range of conditions (for example, various containers, quantities of vaccine and various types and quantities of ice packs).

Data Loggers

A data logger contains a measuring circuit to measure temperature, a microprocessor to convert the measurement to numerical data and a memory to store the measurements. The data logger is setup using compatible software on the computer and the interval between measurements (for example, from one second to six hours) is chosen. The logger is then disconnected from the computer and works as a standalone unit,

measuring temperature at the set interval. The logger is a small, plastic coated, usually waterproof device. After data has been collected, the logger is reconnected to the computer to display the temperature variation as a graph.

Conservation of vaccine in storage

Freeze-dried vaccine that is stored under vacuum is best stored at 2-8°C. If frozen, the shelf life of the vaccine will be reduced as moist air may enter the vial when the stopper contracts away from the glass neck of the vial.

Marketing and utilisation of products

In most countries where village chickens are raised, informal marketing networks are well established. These networks may require some assistance to improve their efficiency as the number of chickens and eggs to be sold increases (Alders *et al*., 2001a, b). Consideration should be given to notifying chicken traders in central markets about areas where farmers are vaccinating against ND. ND also causes problems for chicken traders, because it can be difficult for them to buy birds at a reasonable price after an outbreak. Traders can also lose money if birds purchased from many different houses and areas become infected with ND and die before reaching the market. Encouragement should be given to the local communities to select their own chicken traders. Just as the community can choose community vaccinators, they can also choose the people to take their surplus birds and eggs to central markets to be sold. In this way, farmers are more likely to get a fair price for their birds and the profits involved in chicken trading are more likely to stay within the community. Training may be required to ensure that sales are fairly distributed and that trips to central markets are made when buyers are more likely to have money (for example, the first week after government salaries are paid) and when major festivals are about to take place (religious or secular holidays).

In many areas, farmers are reluctant to eat surplus chickens or eggs and in some regions, the consumption of eggs by women and children is traditionally prohibited (Alders *et al*., 2001a, b). The conservation of eggs and the hatching of chickens is important in situations of high chicken mortality, where replacement birds are essential. If sustainable ND control programmes can be implemented and chicken numbers increase, the consumption of eggs then becomes an option and a very good use of resources. The egg provides a range of nutrients apart from protein and can make a substantial contribution to the nutrition of children and pregnant women. Collaboration with colleagues working with human nutrition within the Ministries of Health and Education can raise the awareness of families with regard to good eating practices and the contribution that chickens and eggs can make to good health.

Benefit-cost assessments

The benefit-cost ratio of ND vaccination in small, scavenging flocks of village chickens has been shown to be high. Benefit-cost calculations done for the Tigray region of

Ethiopia indicated that ND vaccination was more economically beneficial than the provision of daytime housing, supplementary feeding, cross breeding and control of broodiness (Udo *et al*., 2001). In Namibia, Paskin (1995) noted the negative food security implications of ND in rural flocks and concluded that the control of ND through prophylactic vaccination was highly beneficial with a benefit:cost ratio of 14:8.

An impact assessment study commissioned by the Australian Centre for International Agricultural Research (ACIAR) in 1998 concluded that benefits from research on the control of Newcastle disease in village chickens had already exceeded the total project costs by a factor of 15 (ACIAR, 1998).

Sustainable Livelihoods and the Distribution of Benefits

According to the Sustainable Livelihood Approach, a livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with, and recover from, stresses and shocks and maintains or enhances its capabilities and assets both now and in the future, while not undermining the natural resource base. (DFID, 2000).

ND control in village chickens promotes sustainable livelihoods in rural areas in several ways. Village chickens are the livestock most likely to be raised by poor households. Household food security and income generation is increased with increased chicken numbers. Compared to ruminant species, chickens are more likely to be consumed, or to be sold to resolve immediate family needs such as medicines or school fees. The level of understanding of disease control in livestock and improved husbandry is increased. A study in the Southern Province of Zambia found that households with chickens were better able to survive drought and recover the following year than households without chickens (Songolo and Katongo, 2000).

The community as a whole also gains. For example, in Mozambique where community vaccinators administer the I-2 ND vaccine, two-thirds of the price of the vaccination stays in the community. This occurs because the price of vaccination includes the cost of the vaccinator's labour and the cost of the vaccine. The labour cost per bird is twice that of a dose of vaccine. The ratio of labour costs to the price of the vaccine may vary from country to country, depending on the price of the vaccine and the ability and willingness of farmers to pay. Community benefits will be further increased if some community members become chicken traders and supply local chickens to markets beyond their immediate vicinity.

Urban communities also gain from increased numbers of village chickens. If mortalities among chickens purchased by traders decrease and the number of chickens available for purchase increases, the unit sale price of chickens should decrease. The chicken farmer will sell more birds and so make more money than was possible prior to the introduction of ND vaccination and the number of urban consumers who can afford to purchase chickens will increase as the unit sale price decreases.

The gains for local people in cases where the ND vaccine is locally produced are many. The equipment required to produce the vaccine is almost identical to that required for quality control procedures. Therefore, quality control of ND and some other vaccines can be done before vaccines are dispatched to the field. Employment is provided for local staff and the knowledge required for production of vaccine of a quality suitable for use in village chickens remains in the country. Many of the costs associated with local production also stay in the country, as only some of the inputs need to be imported. The instructions that accompany the vaccine are produced in the local language making them accessible to more people in countries where English is not spoken. Those responsible for the local production of the vaccine are more likely to ensure that the product is of an adequate quality if control activities are implemented in a participatory fashion. When the service or product provider is directly answerable to the client, work is usually of a higher quality.

Extension and veterinary services gain increased prestige and more work when ND control activities are successfully implemented. As noted by Bagnol (2001), most farmers who practice both agricultural and livestock production seek to increase the number of livestock species that they raise when surplus numbers of chickens permit such purchases.

While the use of vaccine is the best way of controlling ND, training packages for field personnel should include information on general husbandry practices that assist with the prevention of disease. Good husbandry will reduce the impact of other diseases and predation, while improving production through strategic supplementary feeding.

Other important considerations in the control of ND

- Avoid the introduction of new birds to flocks during the periods of the year when ND occurs more frequently.
- Do not return from the market with chickens that have failed to sell. Instead, arrange to keep them in another place.
- Sick chickens should not be sold or given away.
- Avoid contact with people, cars and animals that have been in contact with the virus and other parts of infected chickens (eggs, feathers, etc.). Dogs and cats can also spread the virus if they have access to chickens killed by ND.
- Minimize contact between chickens and other poultry, such as ducks, pigeons, turkeys and guinea fowl.
- Good housing can reduce disease transmission. An elevated chicken house that is well ventilated allows faeces to fall through to the ground and so minimizes contact with various infectious agents. Keep chickens and chicks away from the base of the chicken house where the faeces have accumulated or clean the area regularly. Encourage the use of local remedies to control ectoparasites (for example, fleas and mites) in the houses when commercial insecticides are not available.
- House hens with young chicks in a clean, safe chicken house.

- Provide some supplementary feed, such as maize bran, ground grains, green leaves, ground seashells, insects, insect larvae and worms. Good nutrition will give chickens a better chance of combating infections. Supplementary feeding is especially important for chicks, and a creep feeder can be made from local materials to ensure that chicks are able to receive food without greatly increasing the amount of food given to the household poultry flock. A creep feeder also provides chicks with shelter from flying predators.
- Always provide fresh, clean water.

Control measures during an outbreak:

- Isolate all sick chickens.
- Slaughter chickens that are very ill. Do not transport chickens that are ill or dead to other areas that are free of the disease.
- Bury or burn all dead chickens or any part of a chicken.
- Do not vaccinate chickens that are showing signs of illness.
- Once an ND outbreak has commenced in a village, it is best not to vaccinate, as it is impossible to identify birds that are incubating the disease but not yet showing signs of illness. Farmers will often associate the vaccine with the death of chickens that are vaccinated in the face of an outbreak.
- Advise farmers to wait for at least one month after the last mortality before re-stocking.
- Advise farmers to contact the Veterinary Services Officer, Extension Worker or Community Livestock Worker in their area when they notice any signs of illness.

Monitoring and evaluation

Every aspect of the ND control programme must be monitored to ensure that the programme is working efficiently (see Table 4.3). All stakeholders involved with ND control should participate in the monitoring and evaluation process and should help to define the indicators of success. Stakeholders may include community representatives (male and female), government officials, private sector representatives and NGO representatives.

Table 4.3. General inputs and activities required to mount a ND control programme and indicators that can be used to evaluate the efficiency of the programme (Alders, 2001a).

Input/Activity	**Indicators**
Procure appropriate vaccine	Quantity of vaccine produced or imported.
- Import - Produce locally	Value of vaccine sales in comparison to actual costs of importation or production.
Vaccine Quality Control	Quality Control test results.
- Efficacy	

- Potency - Safety	
Central store of vaccine	Maintenance of central cold store.
Central data bases (veterinary and socio-economic)	N° of doses & vials of vaccine distributed nationally. Value of vaccine sales nationally. N° of chickens vaccinated nationally. N° per year and timing of vaccination campaigns. Incidence of ND outbreaks. National village chicken population. Monitor socio-economic indicators.
Distribution of effective vaccine and extension material - Appropriate accounting procedures - Vaccine conservation - Information package	Maintenance of provincial cold store. Appropriate extension material available for farmers, field staff and decision makers. N° of doses & vials of vaccine distributed in each province. Value of vaccine sales per province. N° of chickens vaccinated in each province. N° per year and timing of vaccination campaigns. Incidence of ND outbreaks per province. Provincial village chicken population.
Informed and motivated support staff	N° of staff (male and female) involved in ND control activities. N° of staff with acceptable knowledge of ND control. N° of meetings between supervisors and extension workers and community vaccinators. Quantity and type of refresher courses. Value of vaccine sales per district and per vaccinator. Identification of other diseases and production constraints.
Informed and enthusiastic farmers	N° of farmers (male and female) participating in and paying for vaccination. N° of community vaccinators (male and female) working one year after initial training. N° of community vaccinators working one or two years after the end of the

	project.
Ongoing and systematic administration of effective vaccine to healthy chickens.	N° of chickens vaccinated per household. N° of chickens vaccinated per locality and district. N° of doses and vials of vaccine used by vaccinators. N° per year and timing of vaccination campaigns in each locality. Vaccination costs (price of one dose and administration fee per chicken).
Increased N° of chickens and eggs	Village chicken population per locality and per district. Incidence of ND outbreaks per locality and per district. N° of chickens and eggs sold. N° of chickens and eggs consumed. N° and type of livestock owned by male and female staff. N° of children attending school. Malnutrition rate in villages.

Ethno-veterinary knowledge and Newcastle disease

Ethnoveterinary medicine (sometimes also called veterinary anthropology) deals with folk beliefs, knowledge, skills, methods and practices pertaining to the health care of animals (Guèye 1999; Mathias-Mundy and McCorkle, 1989). Collecting information on ethnoveterinary knowledge in particular regions enables veterinarians to understand farmers' knowledge of the disease transmission process, local remedies that may be worthy of further study and the type of animal husbandry currently being practiced (Alders and Spradbrow, 2001a).

Sources of further information on Ethnoveterinary knowledge

- Ethnoveterinary knowledge and Newcastle disease

  (Alders and Spradbrow, 2001a)

- Ethnoveterinary medicine against poultry diseases in African villages

  (Guèye, 1999)

- Ethnoveterinary Medicine: An Annotated Bibliography

  (Mathias-Mundy and McCorkle, 1989)

- Improvements in Rural Poultry in Developing Countries Website

  (http://www.vsap.uq.edu.au/RuralPoultry)

- Traditional Veterinary Medicine Website

  (http://pc4.sisc.ucl.ac.be/prelude.html)

General Recommendations

- Field activities must be built on the involvement of farmers and community vaccinators.
- The fewer the inputs provided at the start of a ND control programme, the more likely it is to be sustainable. While the livelihoods of village chicken farmers will improve as chicken numbers increase with the control of ND, the overall economic situation of the region is unlikely to change dramatically in the short term. Any input provided by a project (for example, cold chain, provision of transport for the distribution of vaccine, etc.) can continue after the project finishes only if the local infrastructure and local economy can maintain them.
- The characteristics of the ND vaccine selected for use in campaigns must be well-known and the necessary inputs must be available to enable the administration of effective vaccine to chickens in the field.

Further information on family poultry available on the Internet

The International Network for Family Poultry Development Website

http://www.fao.org/ag/aga/agap/lpa/fampo1/fampo.htm

Improvements in Rural Poultry in Developing Countries Website

http://www.vsap.uq.edu.au/RuralPoultry

Network for Smallholder Poultry Development Website

http://www.poultry.kvl.dk

The Australian Centre for International Agricultural Research Website

http://www.aciar.gov.au

The ND control extension package produced in Mozambique contains:

An ND field manual - a 112 page manual entitled 'Controlling Newcastle disease in village chickens: A Field Manual' which aims to provide information to senior veterinarians and veterinary field staff on ND and its control.

An ND training manual - contains a three-day course to train farmers to become successful community vaccinators.

An ND laboratory manual - details the small-scale production and quality control of live, thermostable ND vaccine.

A flip chart - an illustrated A3 flip chart, with clear, largely self-explanatory line drawings and an accompanying narrative. It can be used for training to explain the characteristics of the vaccine and its application. Local frontline extension staff can translate the narrative into the appropriate local language.

A poster - a large black and white line drawing of a rooster, ND vaccine vials and an eye-dropper. The poster provides space for the local vaccinator to write the place, date, time and contact person for the next ND vaccination campaign.

A pamphlet - provides an introduction to ND and its control. It is printed on both sides of an A4 sheet and is easily reproduced. It is useful for front line extension staff, literate farmers, farmers' associations and school children.

An ND vaccination calendar - this highlights the months in which vaccination campaigns should be implemented, prompts vaccinators to place their orders for vaccine well before the campaign begins and reminds distributors when they should have the vaccine in stock.

An ND vaccination song - recorded in Portuguese and three African languages by the Mozambican Musicians Association, the song was conceived after visiting one of the vaccine field trial sites. Its words are included in the Portuguese version of the ND field manual.

An audio-cassette with radio programmes - a radio drama and a question and answer programme in Portuguese and four African languages are broadcast, together with the ND vaccination song on national and community radio. The text of the programmes is included in the Portuguese version of the ND field manual to facilitate the local recording of programmes in other African languages.

A play - this was developed by a local theatre group with experience in community development after visiting one of the vaccine field trial sites in Mozambique. The play runs for 20 minutes and covers most aspects of ND control including the need to vaccinate before chickens get sick and how to pay for the vaccine. As the drama's text is included in the Portuguese version of the ND field manual, it can be used, in the form of role-plays, during the training of extension workers and community vaccinators. Role plays developed and performed by participants are encouraged during training sessions.

The English version of this ND control extension package is available from:

Improvements in Rural Poultry in Developing Countries
Website: Internet: http://www.vsap.uq.edu.au/RuralPoultry
The Australian Centre for International Agricultural Research

G.P.O. Box 1571
Canberra ACTS 2601 Australia
Fax: +61-2-62170501
E-mail: aciar@aciar.gov.au
Internet: http://www.aciar.gov.au

Portuguese version available from:

The National Veterinary Research Institute

C.P. 1922
Maputo, Mozambique
Fax: +258-1-475172
E-mail: inivei@teledata.mz or inive@cfmnet.co.mz
Internet: http://www.vsap.uq.edu.au/RuralPoultry

French version available from:

Food and Agriculture Organisation of the United Nations

Internet:.http://www.fao.org/ag/againfo/subjects/en/infpd/documents/manuals/ND3-FRENCH.pdf

Developing Health and Family Planning Materials for Low-literate Audiences: A Guide

This booklet, prepared by the Programme for Appropriate Technology in Health (PATH), provides clear guidelines for the preparation of extension materials and gives information on establishing the target audience. Although the examples in the booklet refer to health and family planning issues, the approaches used may be easily adapted for use with livestock owners. The guide is available free of charge to developing country organsations or individuals from:

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PATH
1990 M Street, N.W., Suite 700
Washington DC 20036 USA
Fax: +1-202-4571466
E-mail: info@path-dc.org
Internet: http://www.path.org

Quote from the OIE Manual of Standards for Veterinary Vaccines:

"Regulatory authorities in different countries have developed various approaches to ensuring the quality of vaccines. Although alike in their ultimate goal, these systems may vary in the emphasis given to control of the production process (process standards) in comparison with control through testing of the final product (performance standards). The control procedures selected should be those that best fit the conditions under which vaccines are being produced.

The control standards and procedures established for a product define the risk or possibility of producing and releasing a product that is worthless, contaminated, dangerous, or harmful. The acceptable degree of risk may depend on the benefits to be gained by having the product available to prevent disease losses. Thus standards may justifiably vary from country to country or product to product, depending on local animal health conditions.

The optimal quality assurance system should address both production procedures and final product testing in proper balance. An absolutely fail-safe system that would result in no risk of releasing an unsatisfactory product would probably be too expensive to produce with regard to cost of production as well as control. Thus regulatory officials and manufacturers of vaccines must select control procedures that are capable of ensuring an acceptable low level of risk in relation to hazard. Such procedures, however, must not be burdensome to the extent that they inhibit the development and availability of the products needed to provide proper preventative medical care at a cost that is acceptable to the consumer."
OIE (2000b).