

# Country Report: Angola

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POULTRY production in Angola is a traditional domestic activity practised mainly by women and children. It is very important and can be divided into the commercial poultry sector (modern semi-industrial and industrial) on the periphery of the big towns, and the traditional or family sector. The commercial sector involves large investments in the acquisition of poultry, equipment, medication, vaccines, food, etc. In contrast, traditional poultry production practised in rural and suburban areas generally does not involve investments (K. Kama and O. Afonso, pers. comm.). The main constraints to traditional poultry production are instability in the rural areas, shortage of feed and diseases especially Newcastle disease (ND) which kills about 50–80% of chickens each year in the villages. Consequently, ND is a serious problem in areas where appropriate hygiene and prophylaxis are lacking. ND is a contagious viral disease, which can quickly spread through flocks. It appears with higher frequency during the dry weather between June and August.

## Background

After Angolan independence, commercial poultry production was given special attention. It was practised in big State-owned institutions that were supervised by the central body of the Ministry of Agriculture until the start of privatisation in 1988. The last structure, which coordinated and orientated poultry production, was a National Program of Poultry. Its actions were essentially to support commercial poultry activity as well as to stimulate and encourage small-scale family poultry production with the introduction of improved rustic breeds known as Haro Sex Link and Nera Sex Link imported from Zambia and Zimbabwe.

Because of organisational and logistical difficulties, activities were discontinued. The National Livestock Directorate was not involved in extension activities organised by the National Department of Training and Veterinary Extension and the Agriculture Development Institute. Consequently, the rural areas were left without structured interventions for small livestock, especially chickens (K. Kama, pers. comm.). This was brought about by the disbanding of specialised services that existed during the colonial period. Unfortunately, they were not replaced by others that could guarantee the continuity of assistance to the small farmers and peasants. New services with polyvalent (multidisciplinary) extension workers who could attend to this type of activity were also not created.

ND was first diagnosed in Angola in 1957 (Sousa 1973). Preventive sanitary measures were not rigorously and sustainably applied in rural areas for many years, although the rural population before the big armed conflicts accounted for more than 60% of the Angolan population, or around 12 000 000.

A survey of rural family production units in nine provinces in 1997 showed that an average of 40% of the national population lives in rural areas (varying from 21% to 61% according to province) (Proj. ref. Cap. Gest. Econ. and FAO 1997). The entire population owns poultry and small livestock and the population is estimated to be around 6 000 000.

## Newcastle Disease Control

Until 1991, the diagnosis of ND (pseudo-fowl pest) was carried out in two laboratories using haemagglutination and haemagglutination (HI) tests, and the immune response to vaccination was evaluated using HI.

## Preventive measures

The National Directorate of Livestock introduced a Preventive Health Program for the commercial poultry sector which consists of a set schedule of

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vaccinations for breeders and laying chickens. Although ND is not a problem in the commercial poultry industry, monitoring is needed.

The first vaccination is given during the first week with Hitchner B1. Subsequent vaccinations are given at the third, 8<sup>th</sup> and 13<sup>th</sup> week with La Sota clone. They are all administered in drinking water. From the 22<sup>nd</sup> week, chickens are vaccinated each 4 months with the La Sota clone. Other vaccines, anthelmintics, vitamins and anti-stress medication are also administered. All of these are given in drinking water. For broilers, the vaccines are administered only on the 4<sup>th</sup> and 15<sup>th</sup> day.

However, this program has not been implemented in rural, urban and suburban areas for reasons discussed previously, as well as inappropriate dose format and thermolability of the vaccines.

#### **Cost recovery strategy**

Economic restructuring has brought about economic difficulties. This is shown by the low budget distributed to the agricultural sector, which contributes to a lack of human and material resources. Thus, stock breeders and village farmers must share in the costs of preventive services, especially vaccines and laboratory analysis.

Changes are needed in the structure of livestock, veterinary and extension services, and farming organisations. Therefore, rural areas must change to strategies worked out many years ago for the semi-industrial and industrial poultry sectors. Of course, the introduction of new measures must be done gradually.

#### **Problems of Poultry Development and Research**

As previously discussed, the Angolan poultry production sectors have been viewed differently, especially for commercial (semi-industrial and industrial) poultry production on the one hand, and for traditional poultry production on the other.

Traditional poultry production has been given relatively little attention because of lack of coherent policies.

Therefore, Angolan poultry production has suffered severe shortages, especially of maize, a basic component of rations, in these last years, generally because of organisational and economic constraints. The persistent instability in the rural areas also contributed to decreased development of poultry production. In some provinces, production declines have been observed because of the permanently displaced population (N'salambi 1999).

The following factors influence traditional poultry production:

- The poor conditions of hygiene and non-existent application of appropriate preventive health measures.
- Lack of accurate knowledge of animal species distribution at the national level because no national livestock census has been undertaken. Animal species distribution was not a part of the survey of nine provinces mentioned previously.
- Political instability led to an interruption of diagnostic and research activities within the Veterinary Research Institute (IIV). Vaccine production ceased, equipment and materials were destroyed or stolen and the human resource base was diminished. Consequently, ND monitoring and control activities ceased.
- Low priority for traditional poultry production because of indefinite or ill-defined development policies. Therefore, only immediate research priorities are addressed.

#### **Development Prospects**

The existence of markets for poultry products and a poultry production tradition are two fundamental factors which might drive poultry production once the organisational problems and other problems have been solved, especially the lack of livestock extension and spread of available technology.

Therefore, the Veterinary Research Institute plans to undertake progressively the following actions:

- recommence laboratory diagnostic activities;
- undertake a study of local poultry breeds, characterise them and undertake a survey of ND in the rural areas; and
- participate in experimental technology in collaboration with interested public institutions and communities, and participate with national and international NGOs.

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# Country Report: Botswana

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POULTRY-RAISING is the livestock enterprise available to all farming families, even the poorest (Bell 1992). Village chickens comprise the major part of the poultry industry in many developing countries (Spradbrow 1997). Village flocks are small, of mixed age and mostly unhoused or poorly housed. Most village chicken production systems are based mainly on native, domestic species which require very low levels of inputs (Sayila 1999) leading to low output, hence the term 'low input/low output system'.

Village stocks comprise the local unimproved poultry breeds commonly found in developing countries (Crawford 1992), or may include mixed (unspecified) breeds resulting from uncontrolled breeding (Kulube 1990). The terms indigenous, native or traditional chickens are often used as synonyms for village chickens, even where there is a high proportion of non-indigenous blood in the flocks. They are also termed scavenging chickens, where they are allowed to run free in the village surrounds, and backyard chickens where they are kept in a house yard (confined or free).

Backyard poultry production has been a traditional component of small farms throughout the developing world (Branckaert 1995). In Africa, it is estimated that 80% of the poultry population is found in these production systems, that contribute up to 90% of poultry products in some countries (Branckaert 1995; Sonaiya 1995). The population of village chickens in Botswana is estimated to be approximately 3.5 million (Moreki 1997).

The rearing of chickens is popular in rural villages of most resource-poor countries, as a means of providing supplementary food, extra income and employment for family members (Andrews 1990; Jalaludin 1992) and also to capitalise on harvest wastes and inferior grains produced on farms (Sonaiya 1995). Indigenous chickens survive under

unfavourable weather conditions, sheltered or not sheltered, in cages or in tree branches (Nalugwa 1996; Nel 1996). However, if not confined chickens can cause quarrels between neighbours by destroying gardens (Aini 1990; Oh 1987). They are self-reliant, disease-resistant and parasite-tolerant. The management is largely the responsibility of women and children (Losada et al. 1997; Martins 1995).

As a valued enterprise of every household, village chickens play an important role in the developing world, and the absence of a backyard chicken in a rural household is a sure sign of poverty (Nalugwa 1996; Nel 1996). In Zambia, Zulu (1999) reported that indigenous chickens provide the mainstay of the rural economy and contribute to food security and agricultural development.

Attempts are being made to raise the productivity of indigenous chickens in many countries, by improving housing, nutrition and health programs. In their study of indigenous chickens in Indonesia, Sinurat et al. (1992) reported improvements in performance resulting from improved management (nutrition, housing and disease control) and marketing strategies. Future prospects for rearing village chickens are believed to be good, because of traditionally high demand for their meat, which is tasty compared to that of commercial chickens (Crawford 1992).

In order to assess village poultry production in Botswana, a study that covered 10 administrative districts was undertaken.

## Methodology

A total of 1000 rearers were interviewed using a questionnaire in 15 villages of Botswana (Etsha, Gantsi, Hukuntsi, Kanye, Malolwane, Marapong, Masunga, Maun, Mochudi, Mokgomane, Motokwe, New Xade, Parakarungu, Tlokweng and Tsabong). Field surveys started with a pretest of a questionnaire in Bobonong and Molalatau villages in the Central District. The questionnaire was then modified and finalised. The villages chosen were categorised into

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'more urban, rural and remote rural'. Data were collected using a formal questionnaire and through informal interviews (ie. key informants, group interviews, direct observation, village walks). A questionnaire was administered to groups of students from primary and secondary schools.

## **Results and Discussion**

### **Composition of village chickens in Botswana**

There are seven species of poultry kept including chickens, ducks, pigeons, turkeys, peafowls, geese and guinea fowls. Chickens predominate (94%) in all the villages, followed by pigeons (3%) and ducks (2.5%) respectively. Pigeons are mainly kept by boys and are at times sold to generate income. Other poultry species of minor importance include guinea fowls, peafowls and geese.

### **Gender analysis and ownership of village chickens**

Eighty two per cent of the rearers are women while men constitute the remainder. It appears that village chickens have more bearing on the lives of women than of men. However, during the survey the majority of men could not be found at home as they were either working outside the villages or caring for large stock such as sheep, goats and cattle.

### **Reasons for keeping village chickens**

The rearers gave many reasons for keeping village chickens. However, the majority of the rearers keep chickens mainly for meat, as a source of income, meat and eggs, greeting visitors, providing a sanitation service and to a lesser extent for healing rituals. Most of the rearers in Etsha said they use village chickens (not naked neck birds) in healing rituals.

A few rearers use chicken manure to improve the fertility of the soil. The use of manure in fertilising soils is consistent with the findings of Østergaard (1995) and Aini (1990) in South Korea and Malaysia respectively. Other reasons for rearing chickens in order of importance include: for ornamental purposes, heralding the break of the day, tradition or hobby, pest control, bartering, easy to keep, paying debts, for recycling waste and for exhibition at shows and trade fairs. Feathers are used in making pillows. The multiple uses of village poultry reported in this study are in agreement with earlier reports by many workers in Asia and Africa (Aini et al. 1990; Sonaiya 1995).

### **Housing and shelter**

Sixty-five per cent of the rearers in all the villages in this study do not provide housing for chickens. Consequently, birds sleep on tree branches, piles of bricks/blocks, old vehicles, bush fences, walls, under roof overhangs or on top of huts, thus exposing them to risks of predation, unfavourable climatic hazards and theft. Shelter is constructed using locally available material such as old tins, iron sheets, plastic bags, thatch grass, mud bricks or blocks. Gantsi township has the highest number of rearers (87%) that provide housing to village chickens, followed by Etsha (72%), Parakarungu (60%) and Maun (58%). The five villages that have the highest number of rearers that do not provide shelter to village chickens are Mokgomane (92%), Motokwe (90%), New Xade (88%) and Malolwane (78%).

The risk of predation always exists as most rearers confine birds at night but allow them to scavenge during the day. The mother hen and chicks are highly vulnerable to predators if they are not confined at night. Eggs that are laid in the bush are often stolen or eaten by dogs and snakes. Risks of predation and theft are more common with birds that are not confined at night than with those that are confined at night.

### **Management of village chickens**

All members of the household are involved in feeding and watering village chickens, but women and girls are the major contributors. For instance, 82% of the women said they are responsible for feeding and watering village chickens while 6.6% of the men and boys are involved. The contribution of children, family and relatives in feeding and watering of birds is 3.4%, 7% and 1%, respectively. Mainly men and boys construct shelters. The contribution of men, relatives, family and children in the construction of shelters was 2%, 0.2% and 0.2%, respectively.

### **Feeds and feeding**

Birds scavenge during the day and are also given a supplementary diet of cereals (especially maize and sorghum), bran and kitchen wastes. Other feed stuffs include maize products (maize meal and samp), melon seeds, sunflower, brewers grain, millet, mixed fowl feed and beans. Twelve per cent of the rearers said they feed birds mixed fowl feed (mixture of sorghum, maize and sunflower), which is purchased from the stores. Bran is widely used and is obtained from primary schools and milling plants found in the villages. Bran is fed mainly to chicks and usually given wet or dry in various containers or on bare

ground. On the other hand, less than 1% of the rearers feed compounded feed (e.g. growers and layers mash). One per cent of the rearers do not provide feed to birds and the birds depend entirely on scavenging.

Chickens are fed once or twice a day. They are fed mainly in the morning before they roam the village surrounds in search of feed and late in the afternoon as they return home to sleep. The common feeding method is by broadcasting grain on the bare ground. Less than 1% of the rearers provide feed ad libitum, which shows that nutrition is one area that needs to be improved for these chickens to be productive.

### **Breeding and Productivity of Village Chickens**

Breeding in village chickens is uncontrolled and indiscriminate. The male and females run together, resulting in the hen producing chicks all year round. Some rearers cross breed commercial broiler or layer chickens with Tswana birds and they claim that the offspring exhibit superior traits such as improved growth rates. Chick mortality is higher in summer than in all other seasons because predation and disease incidence increases during this period. Confining chicks and giving them creep feeding during high-risk periods (spring and summer) could alleviate the risks of predation. Additionally, hatchability is lower in summer than in other seasons because of high ambient temperatures, level of nutrition and high relative humidity. High temperature and high relative humidity result in most eggs deteriorating in quality. Consumption or sale of eggs should increase during this period.

Tswana hens produce 3–4 clutches in a year and the average clutch size is  $14 \pm 1.69$  eggs. Average hatchability is estimated to be 80%. About  $7 \pm 1.25$  chicks manage to reach sexual maturity, thereby signifying a chick mortality rate of approximately 50%. This high chick mortality could be ascribed to high predation rates and high incidences of diseases, especially Newcastle disease (ND), which occur in spring and summer. Other causes of mortality are bur-bristle grass (bogoma), natural disasters (hail and storm) and accidents caused by vehicles or drowning. Some birds are lost through theft while others that stray into the neighbours' gardens or homes are likely to be killed. Sexual maturity is said to be reached at around 6 months.

### **Genetic composition of village chickens**

The five common genotypes of chickens found in villages include: naked neck (*Na*), dwarf (*Dw*), frizzle (*F*), rumpless and feet feathering. The heat

tolerant genes (*Na*, *Dw* and *F*) are considered important in hot climates and can therefore be incorporated in breeding programs. The frizzle gene appears to be in serious danger of extinction as it was found in one village (Marapong) while other genes were found in all the villages surveyed. *Na* and *Dw* genes also appear to be endangered in Etsha and Parakarungu. Egg production for *Na* and rumpless birds is said to be higher than that of other genotypes. But hatchability for *Na* birds is said to be higher than that of rumpless birds. Consequently, rumpless birds appear to be selected against.

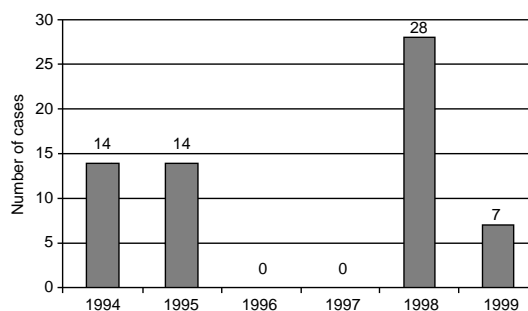
### **Diseases and health control**

The common diseases of village chickens are ND, fowlpox, coccidiosis, a disease called *saakhubama* (swelling of the bursa of Fabricius, infectious bursal disease). In the latter stage removal of bursa of Fabricius by rearers and treating with salt or chilli is claimed to allow the birds to recover from this sickness. Of these, ND was found to occur frequently and caused major losses. The majority of the rearers said that they did not know the time that ND occurred while 20% said it occurred between summer and autumn (January to April). However, it appeared that ND occurs mainly between September and January. ND has different names in different locations such as *dihamba* in Etsha, *muchachapansi* in Parakarungu and *mokorobalo* or *korobela* and/or *leroborobo* in all the villages. The common local name for ND is *mokorobalo*.

### **Newcastle disease**

According to the European Union, ND is an infection of poultry caused by any strain of the paramyxovirus 1 with an Intercerebral Pathogenicity Index (ICPI) in one-day old chicks greater than 0.7. The Office International des Epizooties (OIE) defines ND as a disease of birds caused by strains of avian paramyxovirus type 1, significantly more virulent (ICPI more than 1.2) than lentogenic strains, such as the vaccine strains Hitchner B1 and La Sota. Some species of birds may be infected with virulent strains of ND virus without showing any clinical signs.

In Botswana, ND is a notifiable disease, in compliance with the Disease of Animals Act (CAP 37:01) and in fulfilment of International Animal Health Code Article 1.2.02 to 3. The disease is characterised by sporadic outbreaks with major epidemics over time (Figure 1). The disease tends to be self-limiting as it kills almost all chickens. Chicken owners are expected to purchase their own vaccine. Vaccination programs are therefore not well coordinated and backyard chickens suffer the most because they not regularly vaccinated.



**Figure 1.** Newcastle disease cases (1994–1999).

Most districts recorded at least one case of ND in the last six years. Department figures reflect only the cases that were reported in the last six years and therefore are an underestimation of the disease situation. The cases ranged from 0 to 3 a month with a monthly mean of 1 case. Most cases occurred during the months of May to November with August predominating.

#### Control of diseases

The use of traditional remedies in controlling diseases predominates in all the villages, especially in the remote areas where drugs and vaccines are not

easily accessible. Two per cent of the rearers said that they used vaccines to control diseases while 13% used drugs. The common veterinary drugs are Terramycin, oxyphen, oxytetracycline and sulphazine. Both human and veterinary medications are used in treatment of diseases. For instance, blue stones that are used by humans to treat wounds and tinea are also used against fowlpox scabs. Other human medications used by the rearers are Vicks, Eno, Disprin and Compral. Extracts of onions and garlic are also administered.

Potassium permanganate (PP) is the common remedy used and is used before and during disease outbreaks. However, there are divergent views on its efficacy in controlling and treating diseases. For instance, while some rearers said it was effective others said it was ineffective suggesting that its efficacy has to be evaluated. Various remedies of plant origin are used against various ailments (Table 1). It appears that they are used mainly against ND.

The low use of vaccines by the rearers could be attributable to the fact that most vaccine packs come in 1000 doses. In addition, lack of housing makes catching birds for vaccination difficult, thus contributing to high incidences of ND. It would therefore be necessary for the rearers to group together to share the cost of vaccines. The advantage of this would be that the vaccine would not be wasted and the majority of chickens would be vaccinated against ND.

**Table 1.** Remedies of plant origin used to control diseases.

Local name	Common name	Scientific name	Part used
Pelobothoko	Wild karmedik	<i>Dicoma</i> sp.	roots, leaves
Motsaodi	African mangosteen	<i>Garcinia livingstonei</i>	leaves
Sebete	*	<i>Senna italica</i>	roots
Kgophane	*	<i>Aloe sebriana</i>	leaves
Mokgopha	*	<i>Aloe</i>	leaves
Sengaparile	Grapple plant	<i>Harphagophytum procumbens</i>	roots
Motlopi	Shepherd's tree	<i>Boscia albitrunca</i>	leaves
Moologa	Lavender fever-berry	<i>Croton gratissimus</i>	leaves
Morula	Marula	<i>Sclerocya birrea</i>	bark
Mopane	Butterfly tree	<i>Colophosepermum mopane</i>	leaves
Mogonono	Silver terminalia	<i>Terminalia sericea</i>	roots
Lengana	African wormwood	<i>Artemesia afra</i>	leaves
Sekaname	*	<i>Urginea sanguinea</i>	bulbs
Monepenepe	Long tail cassia	<i>Cassia abbreviata</i>	roots, bark
Mosimama	Ragwort	<i>Senecio strictifolius</i>	leaves
Mositsane	Sumach bean	<i>Elephantorrhiza burkei</i>	roots
Letswai la khudu	*	<i>Oxygonum alatum</i>	roots
Lebolara	Tobacco	<i>Nicotiana tabacum</i>	leaves
Kwii	Onion	<i>Allium cepa</i>	bulbs
*	Garlic	<i>Allium sativum</i>	bulbs

\*Common names not available

### Parasites and control measures

The common parasites of poultry reported by the rearers were tampan ticks, mites, fowl lice, hard ticks and mosquitoes. As in diseases, traditional remedies also predominate in parasite control. The common remedies and/or methods used against parasites include ashes (cold and hot), paraffin, automobile oil, Jeyes fluid, Cape aloes, Doom Spray, potassium permanganate (PP) and boiling water. Boiling water and ash are poured in the shelter or where birds usually sleep. Karbadust (Carbaryl 5%) is the common chemical dust used by the rearers. Rubbing or smearing paraffin and automobile oils on the birds is said to be effective against parasites. PP is administered orally or birds are bathed in its solution. According to the rearers oral administration of PP renders blood of birds bitter or unpalatable thus helping to control parasites. Bathing birds in a solution of washing detergent such as OMO and SURF is also said to be effective against parasites.

### Marketing of village chickens and eggs

There is no organised marketing for either village chickens or eggs. Chickens are sold live to meet family needs and most of the sales occur from home. Only 65% of the rearers said they sold birds. Young males are the first to be sold, while most of the females are used for breeding. The average prices for adult male and female birds were P 17.97 ± 2.92 and P 17.17 ± 3.83 respectively (USD 1 equals 5 P). The average price for a dozen eggs was P 5.28 ± 0.16 compared to the average retail price of P 6.31 for eggs from commercial layers. Eggs were expensive in Mochudi (P 8.16 per dozen) and cheaper in Malolwane (P 2.52 per dozen) while chickens were expensive in New Xade (P 23.13 per bird) and cheaper in Marapong (P 12.24 per bird). Eggs are seldom sold and/or given to children to eat as they are used mainly for hatching. Sale and consumption of eggs is likely to increase in hot months when hatchability is low, during festive periods such as Christmas and when the schools open.

After selling chickens and eggs, 44% of the rearers use the money to buy food for their families. The money from sale of village chickens is also used to pay school fees, buy school requisites (pens, pencils, uniforms and books), buy additional birds, pay contributions at burial societies and at the church. Money is also used to buy large stock (goats and sheep), kitchen utensils and to pay traditional doctors.

### Constraints in Village Poultry Rearing

The five major constraints identified by the rearers in order of importance were diseases (20%), lack of

funds to build shelters and purchase feeds (19%), lack of technical support (13%), lack of shelter (9%) and predation (8.5%). The destruction of gardens by village chickens, which often results in quarrels with neighbours reported by six per cent of the rearers in this study, is in agreement with findings by Oh (1987) in Malaysia. Other constraints mentioned were inadequate supply of veterinary requisites, inadequate feed supplies, parasites and poor growth rates.

The predominance of traditional remedies in the control of diseases and parasites could be ascribed to the long distances that the rearers have to travel to purchase medication and vaccines. This therefore suggests that the use of thermostable vaccines such as Australian NDV4-HR, and I-2 that are suitable for the village environment should be promoted. Inadequate technical support from the extension and veterinary services also contributes to high mortalities. It is apparent that the extension service concentrates on commercial poultry while ignoring village chickens probably because of the low status given to these. The rearers indicated that they would like to be trained in poultry husbandry through seminars, workshops or field courses.

### Recommendations

The following recommendations are made:

1. Village poultry rearers should be trained in general poultry husbandry through seminars and field days.
2. A rural poultry financial scheme should be developed similar to the Bangladesh model. Alternatively, the Financial Assistance Policy (FAP) scheme should be extended to rural poultry production in the future.
3. Investigations should be carried out in such aspects as nutrition, housing, immunology, diseases and parasites. Also, the efficacy of traditional remedies in health control should be evaluated at research stations and on farms.
4. Trials involving the Australian NDV4-HR and/or I-2 vaccines should be carried out to test the efficacy of these vaccines locally. Also, suitable carriers of these two vaccines should be established among the local cereals such as sorghum, millet or maize.
5. Surveys should be conducted to determine the frequencies of available genotypes (eg. *Na* and *F*) among Tswana chickens and the extent to which these are endangered.
6. Preservation of genes facing extinction should be undertaken.

## Conclusion

Village poultry production in Botswana could play a major role in providing supplementary food, extra income and employment for rural dwellers. There is a need to improve health delivery to rearers and to evaluate traditional remedies widely used by the rearers to control diseases and parasites. Village chickens form an extensive genetic plasm, which breeders can exploit through selection, perhaps by improving the environment. Because of indiscriminate breeding, it has become apparent that some genes of economic importance that are found in village chickens are in danger of extinction. Training of rearers in poultry husbandry as well as extension agents is necessary if productivity of village chickens is to be raised. It can therefore be concluded that village poultry play a major role in poverty alleviation and that the benefits are likely to be realised with increased support from government and non-governmental organisations (NGOs).

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# Country Report: Lesotho

F.N. Lebajoa<sup>1</sup>

LESOTHO is a small, landlocked country completely surrounded by South Africa and covering an area of 35 355 square kilometres. The whole country has an elevation of 1000 metres above sea level, thus making it the highest country in the world. It is divided into four geographic zones according to elevation. The lowland and foothill regions together contain 7 of the 10 district headquarters. Only 10% of the country is arable, two thirds of which is found in the lowland and foothill regions. Despite the fact that Lesotho's economy is based on agriculture, arable land continues to decline due to soil erosion and rapid encroachment of towns, villages and roads.

The population of Lesotho is growing at the rate of 2.6% per annum and the density per square kilometre has increased from 53 in 1986 to 64 in 1992, while human population density on arable land has increased from 478 in 1986 to 707 in 1992. Population increase has caused a shortage of land for cultivation, increasing the number of landless households. Eighty four per cent of the households are rural and almost all practice subsistence livestock farming. Because of the high number of men working in the mines in South Africa, there are many rural households that are headed by women.

Livestock is reared under extensive farming systems and there is communal grazing. Ownership of livestock is regarded as a source of wealth and livestock are used in traditional activities, such as the payment of lobolo (bride price). However, men rear all types of livestock with the exception of chickens, which traditionally are in the hands of women.

## **The Cultural Importance of Small-scale and Peri-urban Poultry**

Lesotho is a third world country, where the standard of living is still very low. The Food and Agriculture Organisation of the United Nations classifies it as a

low-income food-deficit country. For every child to be able to perform normally each day, whether in class or outside school, a balanced diet is essential. In Lesotho, the majority of the population is poor and live in rural and peri-urban areas. It is worthy to note that chickens are a resource available even to the poorest families. Women have always kept chickens for various reasons, particularly as petty cash to cater for minor but essential household needs such as medical care, food, etc. Chickens are also used in several cultural rituals and traditional doctors use them for healing purposes. It is not uncommon to offer a chicken as a gift.

Among other African countries, Lesotho is rated as having a high literacy rate. Village chickens have played a significant part in the education of the rural people as live chickens and/or eggs are sold to raise money for school fees. They provide a cheap source of protein in comparison with mutton or beef, which are even less healthy in terms of having high levels of undesirable fat. As such, it is more common to find poultry meat in the diet of children and they always carry eggs to school as a snack. Thus, chickens play a significant role in Lesotho's rural economy and household food security.

## **Production Constraints**

Although the importance of increased poultry production was understood decades ago, the Department of Livestock Services neglected to take an active role in promoting the development of the village poultry industry in the country. Priority was given to the more productive exotic breeds for commercial farming, and the Department lost sight of the reasons why the village poultry industry was introduced — to increase the protein content in the diets of rural children.

Therefore, in the goals and objectives for poultry development in Lesotho, there are no specific objectives and concrete activities for improving the production of the village chickens. There is no infrastructure such as cold storage facilities at Livestock

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Improvement Centres, which are centres placed strategically throughout the country to serve the farming community at village level. Consequently, storage of Newcastle disease (ND) vaccines to facilitate routine vaccination programs of village chickens is unavailable.

Extension services to people who keep village chickens are non-existent. It is for this reason that village chicken keepers lack information on various aspects of poultry production. For instance, they are not aware of how to control diseases such as ND despite the fact that they encounter many outbreaks that decimate their flocks. They also do not understand that chicken keeping, if managed well, could be an income generating-activity. No market research for the demand and sale of village chickens and eggs has been done and this factor limits increased production.

There are also no government policies regarding rural credit, which makes it difficult for rural poor people to access funding for expansion of their poultry units and the development of this sector. Lack of specific organisational objectives for rural poultry-raising has resulted in very little participation by the Animal Health Division and lack of information on important diseases besetting village chickens. However, there has recently been a change in government policy.

### Methods of Controlling Poultry Diseases

Village chicken keepers believe in using an aloe preparation for the control of ND. Aloe is ground in water and given to sick birds to drink. Unfortunately, this treatment has not been verified scientifically. It is not an effective control measure because whenever the virus attacks, which is quite often, destruction of the whole village flock results. This is an indication that after outbreaks, carriers remain to infect new, susceptible birds.

Conventionally, ND is controlled through drinking water using La Sota vaccine. However, La Sota is not widely used because of a lack of knowledge on control of ND; the perception that the vaccine is expensive; the vaccine is not available at village level; lack of a cold chain at village level; and it is not affordable by the majority of rural people.

### The Epidemiology of Newcastle Disease

Outbreaks of ND are experienced in the 10 districts of the country all year round with greater incidences in winter. Table 1 shows ND outbreaks in three districts. Although other districts have reported outbreaks, figures are not available. It is not clear whether the appearance of highly virulent strains is

cyclical but it has been observed that alarmingly high mortalities occur in certain years. The differences in the nature and course of the disease cannot be explained with certainty because factors that influence the disease, such as the environment, the virus strain, the natural and acquired differences in the host, as well as dosage, have not been studied.

Village chickens are usually left to roam in search of food. Therefore, transmission between flocks by direct contact between individual birds is significant. Contamination of the range by infected birds leads to infection of healthy birds. Aerosol transmission also plays a major role in ND virus transmission.

**Table 1.** Percentage mortality in Newcastle disease outbreaks in three districts.

District	Total population exposed	Total dead	% Mortality
Maseru	269	241	90
Quthing	63	49	77
LERIBE	424	306	72.16

NB: The incidence rate could not be calculated because the population at risk was unknown.

### Diagnosis and Reporting of Newcastle Disease

Currently, full diagnosis of ND is based on clinical signs and post-mortem pathological findings, as laboratory facilities are inadequate. Upgrading of the laboratory to cater for diagnosis of viral diseases with an emphasis on ND is in the pipeline.

ND is classified as a notifiable disease. As such, the law requires that its occurrence be reported immediately by the fastest means to the nearest veterinary authority. Therefore, at village level a farmer reports to a Livestock Assistant or Livestock Attendant who in turn reports to the District Veterinary Officer (DVO). The latter then reports to the Chief Veterinary Officer (CVO). Normally, the DVO informs the CVO by phone and follows it with a written notification. Once the CVO receives a report on an outbreak, he reports back to the OIE and SADC Epidemiology Unit.

### Role of Extension Services in Village Production

To support the existing poultry industry (improved layers and broiler breeds), there is a well-structured extension service. Farmers receive courses on health and production related issues. There is also a good back-up service from the Department to assist farmers to increase production. In its effort to

contribute to poverty alleviation and income generation through livestock production, the Department has embarked on public awareness campaigns where farmers are being told of the importance of village birds.

It is believed that the role of the extension services in village production is to equip village chicken keepers with knowledge on good management, which embraces the use of local and affordable feed and housing material as a means of cutting down on investment and operational costs. Farmers are given courses on recognition and prevention of important poultry diseases and are advised on the importance of importing desirable birds with proper health certificates in order to reduce the occurrence of epidemics. Extension services should also focus on marketing, teaching poultry keepers how to market their chickens and eggs. It is also important to provide the sector with a good back-up service on health and management-related issues.

### Marketing Opportunities and Strategies

Accessibility by road to most rural areas is not easy in Lesotho because of its topography. Therefore, efficient supply of feed and veterinary drugs is a problem. Second, the prevailing poverty in rural areas makes it impossible for local people to rear exotic breeds of chickens, which are expensive to maintain. Even if they were to rear improved breeds, marketing of these chickens and eggs would require transport to urban areas where market places, such as supermarkets, are found.

Currently the production of village chickens is so small that it cannot even supply local markets. But with increased production, village chickens can serve markets further afield. Nowadays, people are conscious of what they eat and organically produced poultry and eggs fetch good prices. Also, if these products were produced locally, they would be less expensive than imported products. One other advantage that a non-intensive poultry production has is the cheap labour produced by the family unit. Therefore, low production costs mean the sector has a competitive advantage.

The Department is advocating the formation of Village Poultry Associations as a vehicle for village poultry development. This strategy will not only give members of the associations the financial muscle to purchase chickens, veterinary drugs and supplementary feed, but to market their produce as well.

### Economic Potential of Village Poultry

Very low numbers of dual-purpose chickens are imported for distribution to the village community.

The purpose of introducing dual-purpose chickens is to improve the genetic pool of indigenous chickens. The prevailing production of village chickens is too low to satisfy any market demand. These chickens are mainly kept for home consumption. Considering the high amount of imported poultry meat, it is reasonable to conclude that if production of village poultry could be increased it would serve as an import substitute. With increased production, more jobs would be created and people would generate more income. The livelihood of the rural people would improve and fewer people would migrate to towns in search of jobs. Thus, there would be less pressure on the Government to create jobs and develop social infrastructure for the increasing urban population. The country would also benefit from the money circulating within the country instead of paying for imported goods.

**Table 2.** Poultry imports and exports over a three-month period.

Item	Imports	Exports
November 1999		
Eggs	19 098	0
Point of lay pullets	6 160	0
Dual purpose chickens	0	0
Day-old broilers	0	272 000
December 1999		
Eggs	22 281	0
Point of lay pullets	23 100	0
Dual purpose chickens	0	0
Day-old broilers	0	192 000
January 2000		
Eggs	25 464	0
Point of lay pullets	9 500	0
Dual purpose chickens	200	0
Day-old broilers	0	272 000

### Marketing

The Government of Lesotho has created an effective marketing system for commercial egg producers. Marketing centres known as egg-circles were established in seven districts of the country. Each district egg-circle was mandated to accept and sell eggs produced in the district only. When a district experienced egg shortages, it was allowed to import eggs from either South Africa or other districts of Lesotho through a permit system, which was controlled by the Department of Livestock Services. Unfortunately, mismanagement has led to the collapse of these egg-circles. Recently poultry farmers were having a problem with dumping. Some business

people are buying low quality cheap eggs from South Africa, flooding the market and putting local producers out of the market. For village chickens, there has never been any organised marketing system.

Broiler producers have a problem of marketing their produce due to lack of slaughter facilities. Commercial places are only keen to buy meat that has undergone inspection. As such, farmers have to sell at farm gates or to individuals. This results in prolonged periods of depopulation and loss in profits. Since the majority of birds are sold live, producers cannot make use of their feathers, which reduces the income generating avenues.

### **Research and Development**

Ten years ago, village chickens outnumbered the commercial chickens, but because of ND, they are now almost wiped out. In order to achieve their development goal, the Department of Livestock

Services has made project proposals aimed at assisting rural people to increase the production and productivity of their chickens. There is a need to establish an effective and efficient cold chain in the country to enable every farmer to have access to the ND vaccine. Since the conventional vaccine is too expensive for most poor farmers, research on proper handling of the heat-resistant V4 strain vaccine under local conditions and appropriate vaccine delivery to the chickens, is a priority.

Previous projects have unsuccessfully introduced dual-purpose birds. The Department is still encouraging farmers to keep this type because of its high resistance and performance under rural conditions compared to the improved breeds. Reasons for this observed failure are not known. Therefore, research will have to focus on appropriateness of production systems used by farmers and factors associated with poor production.

# Country Report: Malawi

F.L. Kampeni<sup>1</sup>

MALAWI is located in Eastern Central Africa between latitude 9°25' and 17°17' and longitudes 33°40' and 35°55'. It is a land-locked country stretching 900 kilometres from north to south and varying in width from 16 to 160 kilometres from east to west. The neighbouring countries are Tanzania to the north and northeast, Mozambique to the south-east and Zambia to the west and northwest. The total area of the country is 118 000 square kilometres of which 20% (23 726 km<sup>2</sup>) is lakes.

The 1998 census indicated that Malawi has a human population of 9.7 million people. Women outnumber men (52% to 48%). Population density is one of the highest in the world at 90–95 per square kilometres. Eighty-five per cent of the population live in rural areas. There are 2.2 million farming families. Agricultural activities, especially crop growing, are the main occupation with an average land holding of 0.5 hectares.

## Rural Chickens

According to the 1997 National Livestock Development Master Plan Survey, 95% of households own chickens. Chickens are the most popular type of livestock. Other livestock species include cattle, goats, sheep and pigs. The village chicken population is approximately 12 million consisting of various, uncharacterised breeds. The average flock size is 7 to 8 chickens. The chickens are kept under free-range conditions and the chickens are left to scavenge for themselves with little or no supplementation. The main problems associated with village chicken production, in order of priority, are: Newcastle disease (ND), predation and parasites, both internal and external.

## Newcastle Disease

ND outbreaks occur mainly in the hot period of August to December with the peak occurring in October. The reasons for the seasonality are unknown and require further research. The mortality rate ranges from 40–100%. Young chickens 6–20 weeks old are the most vulnerable.

## Control methods

Vaccination campaigns against ND are held annually from May to July. Approximately 30% of chickens are vaccinated but the aim is to vaccinate 80%. The strains of vaccine used include La Sota, Hitchner B1 and inactivated oil emulsion-based vaccine. The live vaccines are administered via drinking water and the inactivated vaccine is injected.

## Problems

Many problems have been encountered in the control of ND in rural areas:

- very few veterinary personnel to cover the 2.2 million households;
- lack of civic education, e.g. some people believe that eating a vaccinated chicken will make them impotent;
- difficulty in maintaining the cold chain;
- lack of funding (field allowances, etc.);
- lack of chicken housing—some chickens have no sleeping quarters; they sleep in tree tops, making them difficult to vaccinate.

## Administrators of vaccine

The vaccine has been administered by government or non-governmental organisation extension workers.

## Payment

The charge per dose is MK 0.15 (USD 0.33). During the campaigns, farmers are encouraged to contribute money to cover the purchase of the vaccine. Farmers are organised into groups (clubs) to facilitate the purchase and distribution of the vaccine.

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### **Vaccination campaign results**

Where campaigns have been strictly implemented, the following results have been observed:

- flock size per household increased to an average of 15;
- increased income from sales of eggs as there were surplus eggs after meeting requirements for replacement stock;
- increased consumption of eggs from 9 to 33 eggs per person per annum; and
- consumption of poultry meat increased from 2 to 6 chickens per year per family (GTZ survey).

### **Village chicken research**

#### **V4 Newcastle disease vaccine research**

Research into the control of ND in rural areas using the original V4 ND strain was initiated in 1981. The research was done in selected hot districts of the country by a development project. When the project ended in 1983, the research terminated without conclusive results.

#### **Performance of naked neck and other village chicken breeds**

Investigations into the performance of naked neck and other village chicken breeds are ongoing. Results are not yet available.

#### **Village chicken improvement: the Malawian experience**

The Malawian Government has supported a village chicken-upgrading program since 1964. The objective of the program is to improve the performance of the local chickens with regards age at maturity, egg production, egg size and body size.

The program involved crossing the big bodied, dual purpose Black Australorp male with the local female chicken. The offspring produced more eggs, bigger eggs, had a larger body size and matured earlier (they reached point of lay at 24 weeks) while maintaining the hardiness of local birds. The Black Australorp birds were produced on government farms and were distributed to designated selling points throughout the country on pre-announced dates.

The program became very popular. The Black Australorp was dubbed the 'Mikolongwe bird' and this became a household name.

As the years passed, problems started to occur, namely:

- people lost track of the original objective and the preference change from male to female chickens;
- some kept the Black Australorps among themselves for egg production;
- the heavily subsidized Black Australorps became a cheap source of chicken for the table;
- no disease control or husbandry packages accompanied the chickens to the villages and consequently, many died of ND, internal and external parasites and malnutrition; and
- there were too few birds produced to meet demand so the birds ended up being bought by civil servants, or by influential people in society and not the villagers.

These problems almost lead to the collapse of the program. The African Development Bank (AfDB) has recently commenced supporting the program through the National Livestock Development Project. The above problems are to be dealt with in the following manner:

- the Black Australorp birds will no longer be subsidised;
- only male chickens will be distributed to villagers;
- female chickens will go to village mini-breeders who will be involved in the multiplication of the birds;
- disease control and breeding packages have been developed to accompany the chickens to the villages;
- only farmers who are members of the multiplier clubs/groups are to be supplied with the birds.

### **Projects with village chicken components**

Village chicken production and multiplication is currently being supported by the following projects:

- GTZ supported Basic Animal Health Services Project (BASHP);
- AfDB supported National Livestock Development Project; and
- Danish International Development Agency supported Livestock Project (DASPS II).

# Country Report: Mauritius

J.M. Reshad<sup>1</sup>

MAURITIUS, an island of volcanic origin, is approximately 1850 square kilometres and situated about 890 km off the east coast of Madagascar. It enjoys a semi-tropical climate with summer (November to April) and winter (May to October) as the two climatic seasons. The average rainfall ranges between 200–500 cm, with the centre of the island being the wettest and the southwestern part the driest.

It is basically an agricultural country with sugar cane being the main produce. The textile and tourist industries have developed so much during the past decade that the economy is now re-oriented to make sugar, textile and tourism as the three important pillars of the Mauritian economy.

The human population is estimated to be 1.1 million, which also includes some 40 000 people living in Rodrigues, a dependency island of Mauritius situated 560 km to the northeast of Mauritius. Due to recent development throughout the island, it is now difficult to distinguish the rural areas from the urban areas as basic facilities are accessible everywhere. However, if the towns and city limits are to be demarcated physically, it can safely be assumed that the rural areas represent about 80% of the island.

Due to lack of space and limited natural resources, activities related to animal breeding and production are limited and we rely mainly on importation from Europe, Australia, New Zealand, Africa and India.

The poultry industry is one sector that is fully developed, and Mauritius is self-sufficient in poultry; in fact, day-old chicks are even exported to neighbouring countries like Madagascar and the Comoros Islands. Poultry meat is by far the most popular and accepted meat by the population and the per capita consumption is 19.0 kilograms per year.

The government operates a Poultry Production Centre that operates as a facilitator for breeders and

farmers. The Poultry Breeding Centre sells day-old chicks (broilers and layers) to small and intermediate breeders. The yearly sales amount to some 600 000 day-old chicks and represents about 30% of layers. The small poultry breeders are also grouped under cooperatives and benefit from other government incentives.

The private operators have fully integrated modern farms with automated systems for the rearing of broilers and there are four such farms on the island. They are responsible for the production of 21 000 t of processed chicken per year.

The small breeders can be further regrouped into various categories depending upon the number of poultry they raise. Generally, it varies from 50–500. A few intermediate size poultry units are also operational and they produce about 1000–5000 chickens at any one time.

Some 20 years ago, when the industry was in its embryonic stage, people in the rural areas mostly used to raise local poultry at the backyard level. Nowadays, due to industrialisation, this activity has nearly vanished and local backyard poultry is more or less non-existent in Mauritius. However, backyard poultry is still a major occupation on Rodrigues Island, which has an estimated village chicken population of about 400 000 at any one time. In Mauritius, local poultry has been gradually replaced with commercial broilers and layers and the backyard has been modified into small holdings for chicken rearing.

Because of regular imports of parent stock and sometimes grandparent stock by poultry operators, poultry diseases have been introduced into the island. Two diseases of economic importance are Newcastle disease (ND) and infectious bursal disease.

## Newcastle Disease

ND has been present for a long time and it has a characteristic seasonal incidence. The virus was first isolated in 1985 at the Animal Health Laboratory and it was subsequently typed by Dr Alexander of the

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International Reference Laboratory for Avian Ortho- and Paramyxoviruses, Weybridge. The field strain is a velogenic type which can cause mortality in susceptible chickens ranging from 15–80%. The clinical signs being those of inappetance, droopy wings and neck, cyanosis of the comb, whitish to greenish diarrhoea, followed by death. The nervous, respiratory and viscerotropic types have been diagnosed on the island.

Over the years, ND has cost the country a lot in terms of mortality and lack of production. In 1986, these losses were estimated to be MUR 10 million per year.

### Newcastle disease control

Control was always effective when hygienic practices coupled with a sound vaccination program were applied. In spite of vaccination, the disease used to crop up at seasonal intervals and mortalities due to ND were reported and confirmed. Surveys revealed that the vaccines were not utilised by the majority of the breeders.

Radio and TV programs used to be presented by the Veterinary and Extension Services of the Ministry of Agriculture with the objective of reaching the maximum number of farmers. These educational programs used to be prepared on a quarterly basis in the early 1980s and now similar programs are broadcast by the Extension Services. This publicity about vaccination and sanitation of the poultry operations was an important tool in the control of the disease on a national scale. The impact was great, since many breeders started vaccinating their poultry on a regular basis. Currently, it is

estimated that about 95% of the small holders vaccinate their stock.

### Vaccine production

ND vaccines are produced at the Animal Health Laboratory of the Ministry of Agriculture. The first production was performed in the early 1950s. It was basically the passage of commercially available vaccines in embryonated eggs.

At that time, the requirements per year did not exceed 100 000 to 200 000 doses. Vaccines produced this way were tested by a challenge test before being put on sale to the public.

Vaccine production took on a new dimension during 1984 when a new concept of production was applied. Vaccines produced were the Hitchner B1, La Sota and Fowl Pox. The Hitchner vaccines were utilised in the young chicks and La Sota in older chickens. The vaccines were produced, titrated, mixed in PBS and dispensed in sealed plastic bags, which were immediately frozen. The vaccines were sold in doses of 30 and 45 in a frozen state.

Shortly after this, the quality of vaccines produced was improved by introducing freeze-drying techniques. The vaccines also underwent quality controls and international standards were maintained as far as possible. These were commercialised in vials of 100, 200 and 500 doses and meant to be utilised by the small breeder. During this period, both the frozen vaccine and the freeze-dried vaccines were commercialised. Figure 1 indicates the progress of vaccine sales in Mauritius. There has been an increase in the use of the vaccines in response to the publicity and modification of the vaccination program.

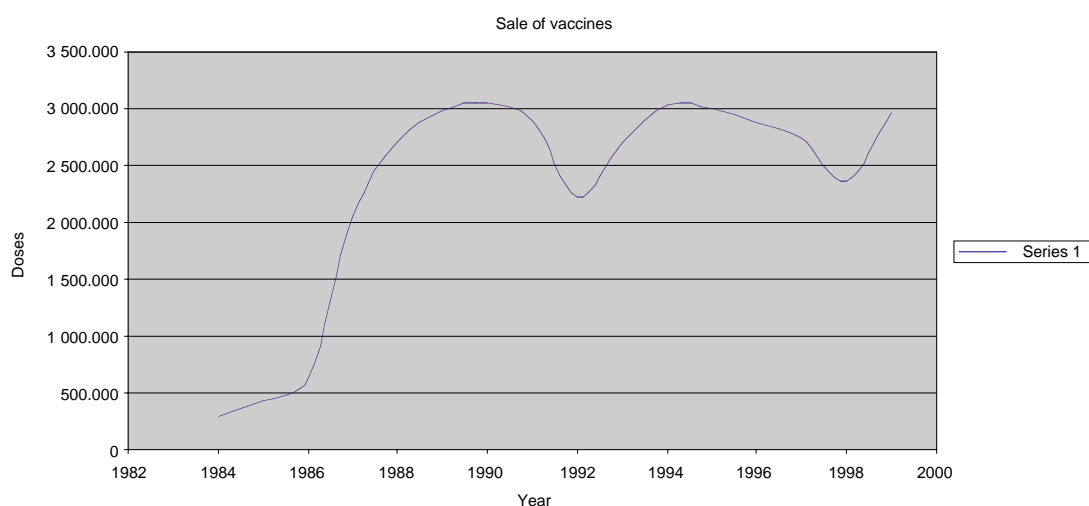


Figure 1. Vaccine sales in Mauritius between 1984 and 1999.



The major development in ND vaccine production came in 1987 when the original Australian V4 strain obtained [NB: not the heat resistant V4 strain selected for enhanced thermostability] as a gift from Wisconsin was first tried as a pilot project among the large producers with conclusive results. The vaccines are now used by the small producers as well. Because of numerous advantages in the V4, the production of the Hitchner and La Sota strain vaccines have now been discontinued. Now, only freeze-dried vaccines are commercialised.

### **Newcastle Disease Control in Mauritius— A Success Story**

For a few years, the incidence of ND has been reduced to isolated pockets that are reported occasionally. On close examination, it is always attributed to non-vaccinated poultry. During 1999, no outbreaks of ND have been officially reported. Mauritius has managed to control this disease effectively because of the following reasons.

#### **Improved vaccine technology**

New techniques of vaccine production have undoubtedly helped to reduce the incidence of ND outbreaks by protecting the birds effectively. The vaccines that were prepared and sold in the earlier days were of poor quality and, being in frozen form, the vaccines would often melt during transportation. By the time the farmer was ready to use the vaccine, it would have lost its potency. Freeze-dried vaccine is more stable and the V4 strain vaccine is thermostable. Nevertheless, farmers are requested to use a thermos flask for carrying the vaccines.

#### **Radio and TV programs**

Education of farmers is an important way of conveying information on proper vaccination, dilution of vaccines, and use of dechlorinated water. Earlier campaigns have been so successful that almost 95%

of the poultry farmers now regularly vaccinate their stocks. The educational programs have also been used to spread information on other aspects of breeding, such as rearing of poultry under hygienic conditions and control of parasites.

#### **Decentralising sale of vaccines**

Poultry vaccines used to be sold at a central point and farmers from all over the island would come a long way to purchase the vaccines. The sales were decentralised by supplying freezers to five sub-offices in order to bring the vaccines nearer to the farmers.

#### **Change in vaccination program**

Challenge and serological tests carried out at the laboratory indicated the best program to apply under local conditions, and the initial vaccination schedule was modified. The actual program consists of vaccination of one-day old chicks, a booster at 10 days and a third vaccination at one month. Layers are to be re-vaccinated after 2–3 months to ensure continued protection to the chicken.

#### **Use of V4 vaccine**

The use of V4 vaccine has had a major role in controlling and eliminating Newcastle disease. It is the vaccine to be utilised in tropical countries and especially in countries where backyard poultry-keeping is an active operation.

The advantages of using V4 vaccine are:

- a high titre is always obtained during vaccine production;
- there are insignificant embryonic deaths and better harvest of allantoic fluids;
- they are thermostable and hence efficient under tropical conditions;
- autovaccination occurs; and
- it is practical to vaccinate poultry in drinking water or incorporated into feed.

# Country Report: Mozambique

A.P. Mavale<sup>1</sup>

IN MOZAMBIQUE, priority has been given to ruminant production based on availability of pastoral resources. However, village poultry production is an important component of rural development. Poultry constitute almost the only source of animal protein and an important source of income for the majority of rural families.

The potential for village poultry production in Mozambique is enormous. According to the 1997 census, the human population of Mozambique is around 16 million. The majority of these people (71%) live in rural areas and have a tradition of poultry keeping, especially chickens and to some extent ducks. On average, each family is composed of 5 members. In 1970, it was estimated that there were 1.4 rural chickens per head of population (Macamo pers. comm.). Estimates have shown that in 1995 rural chickens were kept in small flocks ranging between 5 and 10 chickens with an average size of 7 per household (Wethli 1995; A. Mattick pers. comm.). Taking these figures into account, the number of village chickens can be estimated at about 16 million.

In spite of all these facts, village poultry are still a neglected resource and there are numerous constraints to their development. These include poor management, scarcity of feed, lack of housing, predation and diseases. Newcastle disease (ND) is considered to be the most important constraint, causing heavy losses every year in village flocks throughout the country.

## Village Poultry Production Systems

Village poultry production is a subsistence system in which the majority of chickens in the country are kept. It is generally practised by people living in rural areas.

The main chicken (*Gallus domesticus*) breeds used are of indigenous type and are generally multi-coloured and of small size. The average body weight of a hen is about 1 kg and of a cock about 2 kg. These breeds are believed to be more resistant to the harsh environmental conditions and prevalent diseases (Wethli 1985) than those used in intensive systems. Flocks contain birds of different ages with a predominance of females. Males are frequently sold or consumed before adult age and thus there are usually only 1 to 2 adult males per family flock. These local breeds are also preferred by the rural and urban population due to their taste though they are slightly tougher than commercial chickens.

Village chickens obtain food predominantly by scavenging in the surrounding environment. Their food consists of worms, insects and greenery that are abundant during the rainy season and scarce during the dry season. Apart from scavenging, they sometimes receive scraps of human food and crop wastes.

Housing is not always provided (Wethli 1985). When it does exist, it is constructed of local material and is intended to prevent predation during the night. In some families, chickens are accommodated in the owner's house, particularly during the brooding period. Where there is no provision of housing, chickens roost in trees and they make their nests in the bush, which increases the possibility of losses due to predation.

Most hens lay and hatch eggs during the rainy season and very few chicks are seen during the dry season. This may be linked to the availability of feed, which may influence fertility, and the incidence of disease. Hens lay two to three clutches of about 8 to 12 eggs each per year. Fertility and hatchability are satisfactory but each hen may raise only 2 to 4 chicks to maturity. Hens generally start laying eggs at about 6–8 months of age (Wethli 1995; A. Mattick pers. comm.).

The overall standard of husbandry is usually poor and is almost exclusively carried out by women and children as men are either frequently away from home or this activity is not considered to be their

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duty. Since crop production activities and housework occupy most of the women's time, there is very little time available for poultry management. Children also spend most of their time either at school or looking after other animals such as cattle, goats and pigs. This is an important constraint that should always be taken into account when planning any intervention at this level (Mavale 1995).

Apart from chickens, ducks are also commonly kept in extensive systems and are more resistant to many poultry diseases than chickens. However, possibly due to some traditional beliefs or cultural factors, duck meat is not much appreciated. The scarcity of water in some regions of the country also makes many areas unsuitable for duck rearing. Other species such as geese, pigeons and turkeys are seldom seen in rural areas.

Rural poultry are kept for economic and social reasons. Chickens play an important role, as not only a major part of the rural population diet, but also because they provide a source of cash income or they are used for in-kind exchange. Chickens are also used for celebrations held in a village or elsewhere in the country.

### **Constraints to the Production of Village Chickens**

There are a considerable number of constraints to village poultry production in Mozambique. Among these are nutritional deficiencies, predation, climatic extremes, poor management and diseases.

#### **Feed resources**

Generally, rural poultry farmers are poor and they cannot afford to purchase commercial feeds for their birds. They normally produce subsistence crops that in some cases are not even sufficient for their own needs. For these reasons, apart from occasional household refuse and crop by-products, no other feed is provided to the poultry. Thus, almost all the feed for these birds comes from the local environment (A. Mattick pers. comm.). The amount of feed that the environment and the farmers can provide is one of the most important determinants of the maximum size of flocks and their productivity (James 1991).

The feed supply is relatively stable when the environment is able to provide an abundance of food and water during the rainy season. However, this situation deteriorates with the advent of the dry season. During this period, neither scavenged food nor household refuse and crop by-products are sufficient to maintain a satisfactory level of productivity. The birds generally become debilitated and are therefore predisposed to other factors such as

diseases and predation. As a result, higher mortality is generally observed during these dry periods (Mavale 1995).

#### **Predation**

Predators are another serious constraint for rural poultry (A. Mattick pers. comm.). Predators can be classified into two main groups. One group consists of birds of prey, which tend to take young chickens. The other group is mammals such as cats, dogs and wild animals that attack both adult and young birds.

#### **Housing**

The general lack of housing for rural poultry is an important factor that favours losses of birds through predation. During the laying and incubation period in the bush, hens are more likely to be caught by wild animals. The lack of shelter for chicks during the first weeks of life also accounts for considerable losses, for they are easily caught by predators.

#### **Other management factors**

The lack of a housing system has meant that at times of climatic extremes such as heavy rains, cyclones and low temperatures, many birds, especially the younger ones, are often lost. One reason why most of the rural farmers do not provide shelter for their birds to roost in is the fear of theft. Generally, there is lack of provision of nests, protection for young chicks, early removal of chicks from the hens and culling of old and unproductive birds. The market can also sometimes act as a limiting factor because some villages are so remote that it is difficult for farmers to market their chickens and eggs.

#### **Poultry diseases**

The most frequently diagnosed or reported poultry diseases in Mozambique are infectious bursal disease (Gumboro disease), avian salmonellosis and pasteurellosis, parasitosis and Newcastle disease (ND) (National Directorate of Livestock 1998).

ND is endemic in the country, occurring every year mainly in the rural poultry sector. The number of reported outbreaks in rural poultry does not reflect the true extent of the disease. The real number is believed to be far greater than that reported (National Directorate of Livestock 1998). ND is considered the most devastating disease for village poultry (Fringe and Dias 1991). The ravages of ND, which occurs regularly once or twice a year, are by far the greatest constraint to the development of rural poultry in Mozambique (Wethli 1995).

## Control of Poultry Diseases

In Mozambique, the control of ND is essentially based on zoo-sanitary measures and vaccination. Hygienic measures are practicable only in intensively managed chickens, while vaccination is provided for the control of ND in both commercial and rural chickens. Apart from vaccination carried out in the areas surrounding urban zones and commercial poultry units, little has been done to reduce the impact of this disease in village chickens. The selection of indigenous chickens for resistance to ND has also been advocated as one of the possibilities for the control of this disease that needs to be studied further.

In recent years, there have been developments toward controlling ND in village chickens. Experimental vaccinations have been carried out using heat-resistant vaccines such as ITA-NEW, NDV4-HR and I-2, with promising results.

### Vaccination programs

Vaccination of large numbers of village chickens using heat-resistant vaccines is a new experience in Mozambique. Until the present, vaccination campaigns of village chickens have been carried out once a year and are generally free of charge. However, a requirement for payment is being introduced gradually. Table 1 shows numbers of village chickens vaccinated in the past five years.

The percentage coverage is smaller than that shown in Table 1 as the real number of chickens is believed to be far greater than that shown.

The majority of village chickens are not vaccinated, and a number of factors prevent the implementation of vaccination programs in this important sector of the national flock.

Until recently, vaccines used in Mozambique required an effective cold chain and cold storage facilities because these vaccines were thermolabile. For village vaccination campaigns, there is a severe shortage of refrigeration equipment. Cold storage is not guaranteed even at the provincial level, as there are frequent power supply failures.

In village chickens, the large number of doses per commercial vial leads to wastage of large quantities

of vaccine. The large number of doses per vial was primarily conceived for commercial units with several thousand birds in each unit. The vaccinator can manage to catch only a few village chickens a day for individual application of vaccine. The remaining doses cannot be used on the following day, for these vaccines rapidly lose their viability after reconstitution. The existence of several age groups in village flocks makes this even more difficult and costly, as the vaccinator has to use more than one type of commercial vaccine in the same flock.

A significant number of village chickens have no housing and therefore roost in the trees. Even those housed at least during the night, are released early in the morning before any vaccination team can arrive. In this situation, it is extremely difficult to catch chickens for vaccination. Moreover, there is also a need to take into account the timetable of the farmers, as their first priority is usually crop production.

Village chicken vaccination programs using conventional vaccines require the involvement of highly trained people, efficient transport facilities, and many other resources that are scarce and very costly. Most rural areas are not easily accessible due to lack of efficient communication infrastructure. This can make vaccination programs impracticable as they take up large amounts of already limited financial resources.

## Epidemiology of Newcastle Disease

A number of factors may favour the maintenance of the ND virus (NDV) in village chickens. Chickens, other species of poultry, wild birds, non-avian species, man, environmental reservoirs and the characteristics of NDV, play a considerable role in the persistence of ND in village poultry.

Village chickens act as reservoirs of NDV in different ways (Bell and Mouloudi 1998). Birds that have recovered from the disease may shed the virus for a period after recovery (Awan et al. 1994). Latently infected chickens may also act as reservoirs of infection. This situation is more likely to occur

**Table 1.** Numbers and percentage coverage of vaccinations of chickens in Mozambique, 1995–1999.

	1995	1996	1997	1998	1999
No. of chickens	2 569 103	1 244 386	1 899 314	2 161 728	N/A
No. vaccinated	1 486 971	733 390	691 651	1 570 873	2 353 992
Coverage (%)	57.9%	58.9%	36.4%	72.7%	—

when chickens are infected by mesogenic or avirulent strains of the virus or when chickens are partially immune. In vaccinated flocks, mild or hidden infection with virulent strains of the virus may develop and these birds may then become a source of NDV to fully susceptible birds. Clinically diseased birds may constitute one of the most important sources of infection.

Mozambican rural poultry flocks usually consist of a number of species, including ducks as well as chickens. The resistance of ducks to ND is widely recognised. They can be infected with virulent strains of NDV without showing clinical signs although sometimes they may develop clinical disease. Thus, ducks can become a source of infection and contribute to maintaining and transmitting the virus to susceptible chickens in the village. Due to their small number and distribution in the country, other species of poultry are of limited importance in the epidemiology of ND in a typical rural flock. However, the role of these birds as reservoirs of NDV needs to be determined.

Mozambique has a wide range of species of wild birds that are normally in contact with village poultry. Some of these wild birds may be more important as a source of NDV infection for domestic birds than others, due to their varying susceptibility to ND and to the difference in the frequency of contact with domestic birds.

Another source of NDV infection for village poultry can be wild and domestic mammals such as dogs, cats, jackals and rodents. Some of these animals are usually in close contact with village domestic birds.

#### **Transmission of Newcastle disease virus**

The most common route of transmission in village chickens is probably the oral route through the ingestion of contaminated feeds, water and faeces from infected animals. Village chickens normally eat anything they find in the environment, including viscera from other animals (Mavale 1995).

Since the birds are allowed to roam over a wide area, the probability of transmission of NDV by respiratory route is minimal. However, where shelter is provided for roosting, this route of transmission becomes important as birds in a limited space can release an infectious aerosol that may be inhaled by other birds in the shelter. Therefore, this route of transmission is clearly important in intensively managed birds.

The spread of NDV both within and between village flocks is slower than that found in intensive or semi-intensive systems, and the disease can take weeks to pass through the flock and months to pass

through the village (Awan et al. 1994). It appears that factors such as the low density of poultry and the consequent low contact rate as well as the immune status of rural poultry may play an important role in this slow spread of the disease in the village environment.

Another important reason for the movement of live birds is due to marketing. During the dry season, food is generally scarce for rural families. To deal with this situation as well as for other household needs, chickens are sometimes sold at distant markets. These chickens may already be infected with NDV and therefore can act as a vehicle for the disease to spread to distant susceptible flocks. The dry season is also the period in which most outbreaks of ND occur in Mozambique. When an outbreak occurs, chickens may be sold in a desperate attempt to minimise losses due to high mortality. Some of these chickens may have already been infected with NDV and thus the spread of the virus in this way is possible.

#### **Outbreaks of Newcastle disease in rural poultry**

There are many factors that influence outbreaks of ND in rural poultry. These include host characteristics, the presence of other infections and environmental factors.

The characteristics of the host may include the age structure of the flock, the immune status and nutritional status of the birds and breed susceptibility.

The Mozambican village flock usually comprises chickens of different ages whose proportion usually varies during the year. The recurrent changes in numbers of young chickens may influence the occurrence of epidemics of ND.

##### *Immune status of flocks*

The immunity of flocks can influence the occurrence and course of ND. Protection can be achieved either by exposure to natural infection with different strains of NDV that are present in the environment, application of vaccines or by passively acquired maternal antibodies.

##### *Nutritional status of flocks*

Food found through scavenging is generally scarce and of poor quality, particularly during the dry seasons. In this situation, chickens are generally weak, sometimes with metabolic disorders that may result in the reduction of their immune response to vaccines or natural infections with milder strains of NDV and increased susceptibility to more virulent viruses.

### *Seasonality of Newcastle disease*

In Mozambique, outbreaks of ND occur throughout the year, but the peak incidence and severity tend to be at certain periods of the year. According to the National Directorate for Livestock (1980) and Fringe and Dias (1991), most outbreaks of the disease occur from January to March and from July to September. However, Wethli (1995) states that the incidence of this disease peaked twice a year during April to May and from September to October, while it has been reported that in the southern province of Inhambane, ND was generally more serious in the wet season between November and March (A. Mattick pers. comm.). There is therefore a need for further studies as this can influence control programs against this disease. There is some evidence suggesting that ND outbreaks might not occur simultaneously in the different regions of the country. Some factors that contribute to the seasonal occurrence of ND epidemics in rural poultry may be the seasonal changes in age composition of village flocks, scarcity of feed at certain periods of the year, climatic stress, incidence of other infections and village chicken market activity.

### **Diagnosis and Reporting of Newcastle Disease**

Diagnosis is carried out in the field and at the laboratory for confirmation. There is some capacity in the country to carry out clinical diagnosis in the field, but many outbreaks of ND in remote areas are undiagnosed. Sometimes the lack of action from veterinary services discourages village chicken producers from reporting ND outbreaks. Even those outbreaks that reach veterinary services are not all confirmed at the laboratory for various reasons.

Reporting on ND outbreaks in intensively managed chickens is frequent, as most of these units are located in suburban areas. But many outbreaks of ND that occur in rural areas are not reported.

### **Role of Extension Services in Village Chicken Production**

Successful ND control and improvement in village poultry husbandry would not be possible without adequate education and involvement of rural farmers (Fringe and Dias 1991; V. Macamo, pers. comm.). Extension services are involved in educating rural farmers in matters related to improving village chicken production such as nutrition, housing and disease prevention and control. Extension workers are particularly involved in all phases of campaigns for vaccinating village chickens against ND.

### **Resources Available to Village Chicken Producers**

Livestock services and extension services that assist village chicken producers operate at the central, provincial and district levels. Their personnel work together, as the personnel from livestock services are technically capable and those from extension services are knowledgeable on methodology of agrarian extension.

In livestock production, there are two parallel extension services. These extension services are now in the process of unification and will therefore improve extension efficacy and coverage:

- Pure livestock extension, under livestock services, that gives priority to ruminant production, covering only those poultry farmers that also own ruminants. These farmers represent only a small proportion of rural poultry producers.
- Extension services that cover all poultry producers, including those who do not own other livestock species in areas where they operate. However, these services do not cover all districts of the country.

### **Marketing Opportunities for Village Poultry Production**

The marketing of chickens from this system is more active during the dry season. This may be due to the relatively larger flocks at this time of the year and also an attempt by the farmers to avoid the high mortality that occurs towards the end of the dry season. The other reason for the seasonal trend of sales is that there is a need for cash at this time in order to purchase food as the availability of crop products declines.

Village producers market their poultry locally, mainly by barter, by sale at the main roads or by taking them long distances to urban zones. Rural chickens are highly appreciated by both rural and urban populations.

### **Research and Development Priorities**

The health of village poultry is now a priority in Mozambique because their production involves the majority of the Mozambican population, provides an important source of animal protein and contributes to improving food security of rural people.

Strategies for village poultry development include the reduction of poultry mortality through improving effectiveness of vaccination against the main poultry diseases, and improving standards of rural poultry husbandry. Development priorities are to reduce the ravages of ND through vaccination of village

chickens and improving their productivity through better nutrition, housing and general management.

According to these development strategies and priorities, there are numerous areas for research into the village chicken production system, but priority should be given to the following:

- The accurate establishment of the period of the highest incidence of ND in the different regions of the country would help in planning the timing of vaccination campaigns. Research in this area should be given priority. Another useful study would be directed to a better understanding of the factors that are involved in the seasonal occurrence of this disease in the country.
- Heat-resistant vaccines seem to be appropriate for use in village chickens in Mozambique, and these vaccines have been developed. Some research into the most effective ways of delivery of these vaccines has been done with promising results. However, methods of delivery that could be easier and more economical should be sought.
- Scavenged feeds and household refuse are not sufficient to maintain a satisfactory nutritional level in poultry, particularly during the dry season. To address this situation, the availability of alternative feeds for these birds in the village environment should be investigated.
- The productive potential of indigenous chickens under an improved nutritional regime and disease free situation is unknown. Therefore, it would be of value to carry out studies to establish this productive potential of local breeds, as they are also believed to be more resistant to diseases than improved breeds.

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# Country Report: Namibia

## C. Bamhare<sup>1</sup>

NAMIBIA has a land surface area of 823 000 square kilometres and a human population estimated at 1.7 million with about 70% living in rural areas. It is a largely arid country with over 90% receiving less 500 mm of rain per annum. This greatly limits the country's agricultural potential, particularly the growing of grains and cereals needed for poultry production. As a result, commercial poultry farming is not a significant form of farming and most of the chickens are found in small flocks in rural households, farms and urban areas. Chicken and egg production is often omitted in most agricultural statistics. Most of the country's chicken and table egg requirements are provided for by imports.

It is estimated that there are less than half a million chickens in the whole country. Except for a few commercial flocks around the major urban areas (Windhoek and Okahandja), most of the chickens are in smallholder flocks consisting of 6 to 10 chickens per household in both rural and commercial farming areas. An estimated 48% of the chickens are in rural villages. Management of flocks is minimal and losses due to malnutrition, thirst and diseases are significant. Any improvement in chicken production through better management and disease control has the potential for addressing protein requirements of rural families.

### Reasons for Keeping Chickens

Small-scale chicken farming is common and popular among both rural farmers and urban dwellers who utilise chickens and eggs as an important source of protein. Rural diets are generally high in carbohydrate and the inclusion of chicken and eggs adds a much-needed balance to the staple diet. Studies carried out in the Kavango region of the country showed that 90% of all farmers owned chickens. The

same study showed that about 50% of the farmers had chickens as their only livestock. It could be concluded that the chicken is an important livestock in poor households. The situation is likely to be the same in the rest of the country.

Chickens are kept primarily for provision of household meat and eggs and to a limited extent for marketing. In the northern communal areas, chickens are considered a delicacy and often only slaughtered on important occasions like the welcoming of an important visitor (e.g. the husband coming from town) and sickness in the family. At the household level, chickens are more disposable compared to larger livestock such as sheep, goats and cattle, and are therefore more likely to be slaughtered to provide the family with protein and to be presented as gifts.

In some areas, when chickens are slaughtered for visitors, they are given a chance to select their favourite portions before the hosts take a share. In general, there are no taboos regarding the consumption of chicken or eggs.

Among the Herero people further south, chicken meat is not valued much and some adult males do not partake of chicken dishes. Here, chickens are sometimes kept solely for waking up people in the morning. Chickens are generally not kept with a view to selling them for profit. Eggs are seldom gathered for consumption except when they have been abandoned by the hen.

Chickens are kept in all parts of the country with the majority being in backyard flocks. In the commercial farming areas, chickens are kept in small flocks by the farm owners and their workers and the mode of farming is not very different from that in the villages.

### Village Poultry Production Systems

#### Breeds of chickens

A number of indigenous breeds are kept in villages. These include:

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**Table 1.** Distribution of poultry in Namibia.

Region/area	Chicken population	Remarks
East Caprivi	25 500	Rural
Kavango, Omega	44 318	Rural
Ondangwa	49 900	Rural
Opuwo/Sesfontein	12 886	Rural
Otavi, Tsumeb/Mangetti West	6 994	Commercial/urban/rural
Grootfontein/Mangetti East	11 811	Commercial farming areas /urban + rural
Okahandja/Ovitoto	67 177	Peri-urban and rural
Outjo/Khorixas/Kunene South	13 677	Commercial farming area + rural
Otjiwarongo/Okakarara	30 754	Commercial farming area + rural
Gobabis + surrounding areas	37 902	Commercial farming area + rural
Omaruru + surrounding areas	17 779	Peri-urban + rural
Walvis Bay/Swakopmund	10 503	Peri-urban
Hardap	17 705	Commercial farming area
Karas	19 085	Commercial farming area + rural
Windhoek/Rehoboth	84 532	Commercial farming areas + peri-urban
Grand Total	450 523	

Source: Directorate of Veterinary Services, 1999 Census.

- Ovambo line, which comes in a variety of feather colour and patterns;
- Venda line, a black and white chicken, but also available as brown and white;
- Naked-neck line, a heat-tolerant breed available in a number of feather colours and feather patterns; and
- Kavango.

Except for the Venda and Naked-neck lines, which originated from South Africa, the names of the other breeds refer to regions in Namibia from which the chickens originate. The indigenous breeds are dual-purpose; that is, they are kept for production of eggs and meat. The hens become broody and incubate their own eggs. The males are kept mainly for meat and the females for breeding. Chickens start laying eggs from about 4 months of age. The indigenous chicken lines are very hardy and well adapted to the hot climate, thus making them suitable for rearing in isolated areas without electricity and far from suppliers of commercial feed.

Potential production by indigenous chickens is quite competitive compared to exotic breeds. Hens can lay up to 100 to 150 eggs per year if eggs are collected and not left for natural incubation (compared to 220 to 300 for exotic breeds). If the eggs are not collected, approximately 12 eggs are laid before the chicken becomes broody. The fertility of indigenous chicken eggs compares well with that of exotic breeds. The use of old cocks in most villages however, results in fertility being significantly lower (A. van Nierkerk pers. comm.).

There appear to be no breed preferences, but having a distinct feather pattern is a trait liked for ease of identification of individual birds. Extension workers and

researchers promote indigenous breeds in preference to exotics because of their hardiness and reasonable production under minimal management.

Studies done in the North Central region of the country revealed that flock sizes are 8 to 15 adult chickens with a few flocks of up to 30. About one cock is kept for every 10 chickens. The number of chicks varies with the season. They found around nine chicks per household of which only three were expected to survive to 20 weeks. Chick mortality was highest at the end of the hot dry season (August to November) (Muradzikwa, pers. comm.).

#### Housing and nutrition

Housing of chickens varies widely depending on the area. This ranges from traditional housing made of grass and poles in the north to wire mesh fences further south. In the crop farming areas of the north, housing is mainly provided to stop birds from destroying crops near the household. Sometimes no housing is provided and chickens shelter wherever they can find it, including bushes, trees and under grain storage huts. In the Kavango region in north-eastern Namibia, it is estimated that 96% of chicken rearing households had no proper housing and chickens were found perching on kraal poles, felled trees, roof tops, old vehicles and in trees (Toto pers. comm.).

Management is generally non-existent and the chickens practically look after themselves. Extra feed and clean water are rarely provided. It is not surprising therefore, that production is low.

The chickens are kept at the homestead and left to scavenge around the houses to wander in nearby

bushes. Cattle and goat kraals are popular scavenging sites. Their diet consists of insects, greens, seeds, mahangu grains (finger millet) and leftovers from human diet. At night, some farmers close in their birds for protection from predators.

Chickens lay their eggs anywhere and they are sometimes difficult to find. It is not surprising that the eggs may fall prey to snakes and dogs. Approximately 12 eggs are laid in a clutch; free-ranging chickens may produce up to four clutches a year.

Current research emphasises the advantages of providing good housing, shade and provision of supplementary feeding (up to a quarter of requirements) as a way of improving production.

### **Role of women and children**

Although ownership of chickens is claimed by all, the actual management of chickens is minimal. Women play the more significant role in feeding the chickens with kitchen leftover food and providing water. Men sometimes assist in the construction of housing where this is provided. In general, chicken rearing has rather low returns compared to other livestock and so the attention given to them is low. It is not surprising therefore, that rearing is relegated to women and children.

### **Constraints on production**

The major constraint on poultry production by small-holder farmers is the lack of management skills. If production were to be increased significantly, the provision of feed, water and shade would become more significant factors. Training needs to be provided on housing, nutrition and disease control. A study in the North Central region (Muradzikwa pers. comm.) showed the mortality rate of chicks to be about 60% before 4 weeks of age, rising up to 100% in winter. Up to 60% losses of chicks before 4 weeks of age are common. The main causes of losses were identified as predators, theft, cold weather, dehydration, and disease and parasite infestation. Because they are free ranging, chickens are sometimes seen as a nuisance when crops are still young. The high mortality of chicks means that farmers are always trying to build up their flocks.

### **Animal Health Control**

In spite of chickens being raised in small numbers and under free-ranging conditions, significant losses due to disease have been reported. Apart from exceptional cases, the control of poultry diseases, internal and external parasites, is the owner's responsibility. Control of diseases such as Newcastle disease (ND) is only done at government expense where the

disease has been confirmed in an area with large chicken populations. Where losses are likely to be limited to a few birds, the owner is advised to take the necessary control him/herself. No routine vaccination campaigns against any poultry diseases are done except to contain outbreaks.

There is, however, very little in the way of preventive measures practised by the farmers. A few farmers use smoke to control ectoparasites in the chicken houses and some believe that *Aloe vera* protects against ND (Mkandawire pers. comm.).

Newcastle disease, avian influenza (fowl plague) and psittacosis are notifiable diseases, which means that the owner must report their occurrence to the official veterinary services.

The state veterinarian provides diagnosis and confirmation of poultry diseases. Where material is available for post-mortem, laboratory confirmation can be sought. The long distance to villages makes follow-up investigations expensive and hence the cycle of infection and losses may persist.

Of the notifiable diseases, only ND is economically important, mainly because of its potential detrimental effect on the ostrich industry. Avian influenza has never been reported, whilst psittacosis only occurs sporadically. The other important poultry diseases recorded in Namibia in the last few years are summarised in Table 2. It must be noted that a lot more incidents of disease go unreported because of the low economic value placed on chickens.

A number of other poultry diseases have also been reported through the national veterinary information system. These include internal parasites, fungal infections, gout, ascites, unspecified bacterial infections, enteritis, chronic respiratory disease, mycoplasmosis, ophthalmitis and conjunctivitis. Their significance in poultry rearing in backyard is practically unknown.

### **Newcastle Disease and its Control**

Newcastle disease is by far the most important infectious cause of mortality in village chickens. The first outbreak of ND was confirmed in 1950 and controlled by vaccination. Further outbreaks were reported in 1972–73 from several districts in the country. Apart from a single case in a parrot in 1974, no further outbreaks of ND were diagnosed in chickens until 1989 when it occurred in the Caprivi region. The disease has since spread westwards and southwards.

Except for two outbreaks among ostriches in 1995, all outbreaks involved chickens and rarely other poultry. The flocks involved were generally small and reared in the backyard. It is generally accepted that the reported cases are only the tip of

**Table 2.** Reported incidence of some poultry diseases for years 1995 to 1999.

Disease/Cases in year	1995	1996	1997	1998	1999
Infectious bronchitis	0	0	44 (5 foci)	24 (2 foci)	26 (5 foci)
Infectious laryngo-tracheitis	12	0	0	48	0
Fowl cholera	0	0	20 (1 focus)	0	0
Gumboro disease	0	15 (susp.)	Suspected	15 (2 foci)	5 (11 focus)
Fowl pox	9	128 (5 foci)	2237 (20 foci)	137 (11 foci)	157 (19 foci)
Marek's disease	0	0	0	5 (2 foci)	5 (2 foci)
Infectious coryza	205	0	6	685 (4 foci)	4 (1 focus)

**Table 3.** Recent outbreaks of Newcastle disease.

Year	No. of Foci	No. of Cases	% Dead	Remarks
1995	22	6427	54	Cases included 50 ostriches; Ondangwa, Omaruru (5504) and Keetmanshoop reported most of the cases
1996	13	574	88	Most cases around Grootfontein and Otjiwarongo
1997	21	688	73	Rundu and Ondangwa had most cases
1998	19	764	69	ND spread throughout the country, many other foci suspected
1999	12	803	Details not yet available	Widespread

Source: Director of Veterinary Services Annual Reports.

the iceberg and that most outbreaks go unreported. Besides the confirmed cases of ND, more cases which list ND as the causative agent are reported. All diseases (including infestation with ectoparasites) in which nervous symptoms are observed are often reported as ND.

### Epidemiology of Newcastle Disease

Most of the outbreaks occur in backyard flocks and affect all age groups. The virus strains involved are mainly velogenic and respirotropic.

The following are the most commonly reported signs as recorded by veterinarians in their disease report forms in which ND is given as the diagnosis:

- Respiratory signs: difficult breathing, gaping, nasal discharge, coughing;
- Nervous signs: prostration, frenzy, paralysis (legs, neck, wings), inability to swallow, poor coordination, generalised weakness;
- Demeanour: dullness, depression, somnolence;
- Gastro-intestinal: diarrhoea (white, greenish), enteritis, anorexia (sudden onset).

The duration of illness is one to three days (rarely up to seven) and mortality in affected flocks ranges from 10–100% in susceptible flocks. The disease is often self-limiting in that it eliminates the host. The cycle of infection is maintained by premature restocking of flocks and attempts to move already infected birds to 'safer' areas. No attempts at pre-

ventative bio-security, except those imposed by the state veterinarian, are undertaken.

### Diagnosis and reporting of Newcastle disease

Newcastle disease is a notifiable disease. Farmers report deaths or suspected outbreaks based on clinical signs to veterinary officials. Follow-up investigations are done by the local state veterinarian who will submit samples to the local veterinary laboratory for confirmation. Sometimes samples are sent to laboratories in South Africa. Diagnosis is based on serology and histopathology. Virus isolation and typing; and inoculation into eggs to determine cytopathic effects is not done routinely. As with other notifiable diseases, reports of outbreak are sent to a central epidemiology unit at the head office. Reporting officers have an opportunity to validate their diagnosis on a monthly basis.

No attempt has been made to establish if seasonal patterns exist.

The disease spreads through the neighbourhood killing many chickens before vaccinations can control the disease. The disease is introduced to new areas through infected chickens brought from affected areas, often as gifts after a visit. There is continuous traffic of chickens across the country and the situation is exacerbated by attempts to rebuild flocks after disease outbreaks. Wild birds are also believed to act as carriers for ND virus.

**Table 4.** Cases of Newcastle disease in poultry reported from 1995 to 1999.

Cases Mth/Yr	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total foci for year
1995	40	0	41	377	0	0	5601	7	33	50	275	0	22
1996	82	14	229	39	16	0	0	158	0	6	0	39	13
1997	124	0	18	30	18	35	0	90	23	50	76	224	21
1998	60	0	40	10	32	26	123	41	394	23	15	0	19
1999	0	1	639	6	0	9	65	1	0	0	60	0	12

Paskin (1995) noted the negative food security implications of Newcastle disease in rural flocks, and estimated the value of lost protein at N\$ 148.00 (USD 22) per household per annum. Noting the low cost of ND vaccine, he concluded that the control of ND through prophylactic vaccination was highly beneficial (benefit:cost ratio 14.8). Thus, ND control can be an efficient and well-targeted approach at improving food security at household level among the rural poor.

#### Control of Newcastle disease in rural flocks

The disease has been notifiable since 1962. ND outbreaks occurring up to the early 1970s were all rigorously controlled by culling of infected flocks, quarantine and compulsory state-sponsored and controlled vaccinations. Private control of the disease was not permitted. This strategy was abandoned with the introduction of commercial broiler farming in the major centres (Schneider 1994).

The current strategy employed in rural areas involves increasing awareness of the disease. It involves advice to vaccinate all birds within 20 kilometres of a confirmed infected focus, quarantine and movement restrictions. Where suspected outbreaks pose a risk to ostrich farming areas and in cases where many flocks are at risk as in urban areas, vaccination campaigns at government expense are conducted. In general, the owner buys his own vaccine. Farmer cooperation is generally good during government-sponsored campaigns since they are aware of the serious damage that can be caused when Newcastle disease affects a naive flock.

The purchase of ND vaccine and prophylactic vaccination of chickens is only permitted following authorisation by the state veterinarian. Preventive vaccination against Newcastle disease works well when both vaccination and supply of the vaccine is done by veterinary staff, but not so well when farmers have to acquire the vaccine and do it themselves.

The vaccine comes in large doses (usually 1000), which is not suitable for dealing with flock sizes of less than 50 birds, leading to a massive wastage of

unused vaccine. Because of the lack of electricity and other basic infrastructure, maintenance of the cold chain is difficult.

The management systems also make vaccination of chickens difficult. Because the chickens often roam free, it is difficult to catch all birds for vaccination.

#### Economic Potential

The potential for improved chicken production in rural areas will remain good as long as the birds are not fed intensively since most of the feed has to be imported. The generally accepted way forward is to improve indigenous chicken production at household level through better management (feeding, watering, hygiene, and provision of shelter) and control of the major infectious and non-infectious causes of mortality.

#### Institutional resources

A number of projects to improve chicken production in rural areas are currently under way. One of the main projects is based at the Mashare Agricultural Development Institute near Rundu in the Kavango region. Another project active in the North Central region tried to find the impact of disease in backyard chickens and work out various vaccine regimes against ND. The latter study showed chickens to be highly susceptible to ND and that vaccination conferred protection for very short periods (Talavera 1997).

#### Marketing opportunities and strategies

Production of eggs and chickens is generally at a very low level and very little marketing occurs except when owners need cash. The distance of most rural areas from urban areas will continue to limit the market for chickens and eggs to the areas where they are produced. The general poverty in these areas suggests that the local market will also be very limited. Any efforts to increase chicken production must thus be aimed at improving food security at household level. Informal marketing of eggs, live

chickens and chicken stew will however play a small but significant part in the economies of rural dwellers.

### **Research and Development Priorities**

Research and extension efforts should be directed at the main constraints identified as the lack of management skills and poor control of diseases through hygiene, bio-security and vaccination against diseases such as ND. Efforts should be made to make the delivery of vaccine to these remote areas easier. The availability of heat stable and easily administered vaccines would go a long way towards alleviating current problems. The capability of the official veterinary services to control poultry diseases needs to be strengthened. Research and extension should aim to

increase the value of chickens in the context of protein availability at household level.

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# Country Report: South Africa

T. Tsibane<sup>1</sup>

SOUTH AFRICA has a land area of 1 219 090 square kilometres, divided among nine provinces, with a total population of around 40.5 million distributed in the different provinces. People living outside the cities represent 46% of the total population. A total of five out of nine provinces have a high rural to urban ratio: the Northern Province (90% rural to 10% urban population); Northwest Province (66% rural to 34% urban); Eastern Cape Province (64% rural to 36% urban); Mpumalanga Province (60% rural to 40% urban); and Kwazulu Natal Province (56% rural to 44% urban). One of these provinces, Northern Province, is the poorest of all and could be a good starting point for launching a Newcastle disease (ND) vaccination campaign, followed by assessment of the impact such a campaign will have on the community as a whole.

In South Africa, not a lot of work has been done on village or backyard poultry, for many reasons, including the previous laws of the country (apartheid). A majority of these chickens are owned by people who were disadvantaged or in traditionally black-only areas, and who are also sadly the poorest of the poor, without any access to veterinary or extension services. Large vaccination campaigns have not been launched due to financial constraints and priorities, as these birds are not perceived as playing any important role in the economy of the country. They do, in fact, pose a constant and serious threat to the well-established and developed commercial poultry sector, in terms of disease spread, especially ND, as most of these birds are not vaccinated.

Reasons given for not vaccinating these birds include lack of extension services and information dissemination in these areas. Owners do not know about the different infectious diseases and their control or prevention through vaccination. Consequently, they are often faced with a number of

chickens, or a whole flock dying for no apparent reason. For owners who are aware or knowledgeable about vaccination, the cost is a problem, as vaccines available in the market are made for commercial poultry and vaccines are available in doses for 1000 birds, which is not practical for somebody with 5–10 chickens. Another problem is maintenance of a cold chain, which is a requirement for most of the vaccines in use. This is a practical impossibility as some rural areas are very far from the point of purchase of the vaccine, most owners do not own refrigerators, and in some areas or villages there is no electricity supply at all. Most of these birds are free roaming and catching them for vaccination can be very difficult.

In the majority of households, the men have usually gone to the cities to look for jobs, leaving the women to take care of the household. Worrying about vaccinating the chickens is usually the last thing on a woman's mind, as she has to take care of her children and sometimes other members of her extended family.

A lot of work needs to be done in South Africa to develop and uplift poor communities. People in rural areas or villages are usually very poor, and cannot afford most things, but most own at least 2–5 chickens. These chickens are free-roaming (not housed) and scavenge for food, thus the already limited financial resources are not used for feeding or housing, but in return the household gets meat and eggs from these birds.

Poultry could be the best way to uplift the community, as it is not as expensive to maintain as other livestock such as cattle or goats, and both the eggs and meat can be used as an affordable source of protein.

The private sector (commercial poultry sector) can play an important role, such as donating funds for a large-scale control or vaccination campaign. Not only does the community stand to benefit from this, but the risk of disease spread from rural to commercial poultry will also be reduced.

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## Newcastle Disease Outbreaks

Because no work has been done on backyard chickens in the country, statistics have not been collected, and as a result, their total number or an estimate of their numbers is not known. Most importantly, it is not known whether ND outbreaks occur in these areas or not, although there have been unconfirmed reports of chickens dying in large numbers in some of these areas.

ND is a controlled disease, in terms of the Animal Diseases Act (Act 35 of 1984), and the following procedure must be followed in case of a suspected outbreak:

- The Regional State Veterinarian or Animal Health Technician (AHT) should be informed by the owner of the birds, of any suspected disease outbreak. Adjacent landowners must also be informed. If a private veterinarian is involved, it is also his/her responsibility to make sure that the State Veterinarian or AHT is immediately notified of the suspected outbreak.
- The State Veterinarian must in turn notify the Provincial Director of Veterinary Services, initially of the suspected case, then a follow-up of the outcome of the investigation, such as confirmation of the outbreak or not. The Provincial Director of Veterinary Services also conducts an epidemiological investigation, and then reports the findings to the National Director of Animal Production and Health.
- Control measures have to be instituted on the affected property, and these include:
  - Placing the affected property under quarantine (which is only lifted after the outbreak has been successfully controlled, or 21 days after the last outbreak), the quarantine may be extended to adjacent farms.
  - Isolation of the affected birds, with introduction of strict bio-security measures, to prevent further spread, including movement of people, equipment, vehicles, feed,
  - Litter, etc. Nothing is allowed to move off the farm without a permit issued by the State Veterinarian.
  - All birds on the farm and within a 3 km radius must be vaccinated with a registered approved vaccine, making use of the fine spray or eye drop application.
  - Severely affected birds are culled. Culls and mortalities should be properly disposed of, by burial, composting, incineration, or should be moved with a permit in closed containers to an approved rendering plant. Minimal contamination to the environment should always be ensured.

- No trade in poultry products should be allowed, except for movement with permit for direct slaughter at an approved abattoir; transportation should be without stops and along a route where there is minimal risk of diseases spread to other poultry.

## Reported outbreaks 1995–1999

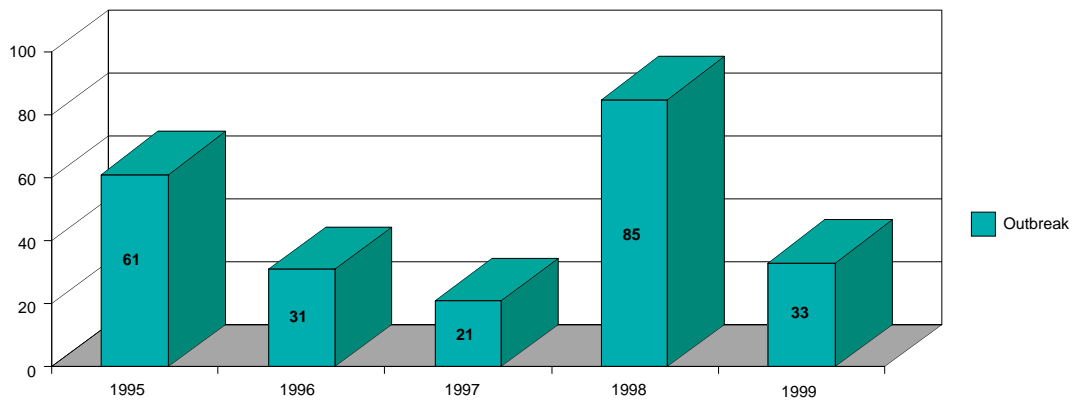
Statistics were obtained from the National Department of Agriculture for all the reported outbreaks of ND that occurred from 1995–1999 (Figure 1). It is however questionable if these figures are a true reflection of the ND status in the country, as most of the outbreaks, especially in rural areas, may be going unreported. This could be due to lack of veterinary extension services in these areas, or to the fact that people do not know that it is a controlled disease that should be reported. To some people the loss of five chickens may not seem so important that they have to travel long distances from their villages to report to the nearest State Veterinarian's office. According to the affected owners, it is not of any great significance as they will not be reimbursed for the dead chickens or benefit in any way from reporting the dead chickens. These combined factors contribute to the possible false picture of a low incidence of the disease that is reported in the country areas.

In 1995, 61 outbreaks occurred throughout the country. An outbreak is considered as any confirmed disease report in a certain area or particular farm. A large number of birds may be affected in one reported outbreak, e.g. 2 million chickens may die from one reported outbreak in a single farm. The incidence decreased in 1996 and 1997, when only 31 and 21 outbreaks were reported successively. There was a major disease outbreak in 1998, when 85 outbreaks were reported and millions of chickens died, but the incidence decreased in 1999 to only 33 reported outbreaks. These figures mainly refer to commercial poultry, where there is constant vigilance, with efficient and rapid reporting and control of disease outbreaks.

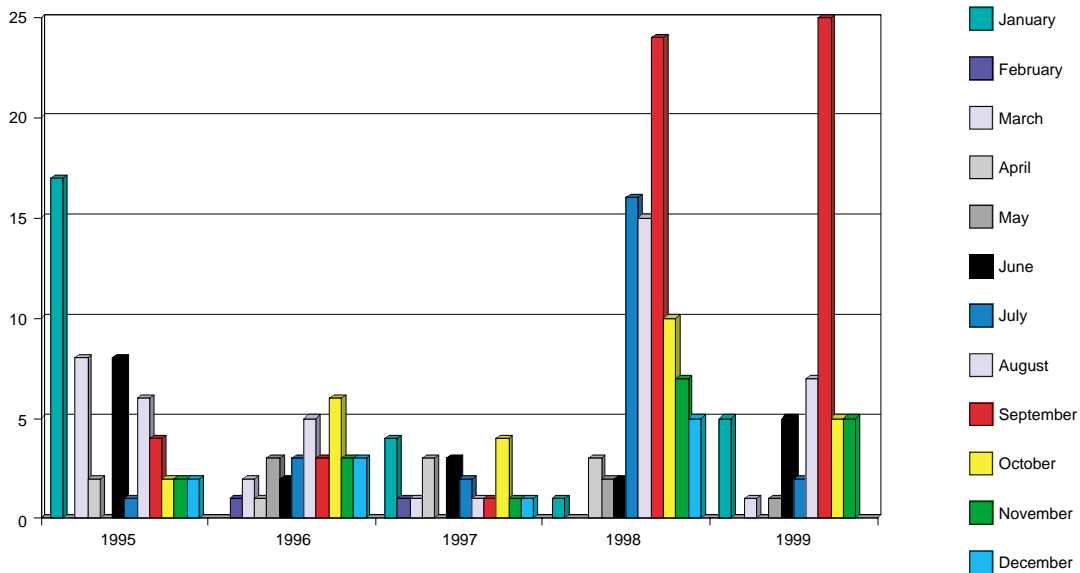
## Monthly occurrences of ND

Statistics obtained from the National Department of Agriculture were studied to determine if there was a monthly or seasonal pattern of disease outbreaks (Figure 2).

In 1995, ND was more prevalent in the first half of the year, from January to June, whereas in 1996, it was mainly in August and October. In 1997, disease occurrence was more uniform throughout the year, with peaks in January, April, June, July and October, whereas both in 1998 and 1999, disease occurrence was more prevalent in the second half of the year,



**Figure 1.** Reported ND outbreaks between 1995 and 1999.



**Figure 2.** Monthly prevalence of ND from 1995 to 1999.

from June and then tapering off in November. For both these years, September recorded the highest number of outbreaks, coinciding with the beginning of spring. It is also very windy at that time of the year; therefore, the high incidence of ND could be due to windy conditions, resulting in its easy spread from one farm to another.

These findings are very interesting and coincide with findings from other SADC countries, where high disease outbreaks were reported especially around September. In the different SADC countries,

September is reported to be the dry season and also harvest time, with increased farm activities, movement and mixing of people from different areas. These factors are thought to be among the reasons for high disease occurrence around that time.

These factors, however, do not apply to South Africa, as most of the outbreaks reported are from the commercial sector. The environment in this sector is strictly controlled, and mixing of workers from different farms is not allowed, and even the mixing of workers or movement from one poultry



house to another on the same farm is restricted. Wind seems to be the only important factor that may be playing a role in the spread or increased occurrence of disease around September.

### **ND Vaccines Used in South Africa**

Both live attenuated and inactivated vaccines are in use in the commercial poultry sector. The live attenuated strains in use include the avirulent Ulster and V4 strains, the lentogenic Hitchner B1 and mainly cloned La Sota strains (clone 30), together with the mesogenic Komarov strain (C. Pienaar, pers. comm. 2000).

### **Research and Development**

The main sectors involved in this area are the Onderstepoort Veterinary Research Institute (OVI) and the Veterinary Faculty of the University of Pretoria (Onderstepoort), which also acts as a Poultry Reference Laboratory.

There are two main departments involved at the OVI. The Animal Health for Developing Farmers program (AHDF), was started in April 1998, with the specific aims of:

- developing appropriate and relevant information modules on animal health to empower resource-poor farmers (RPFs) to recognise, prevent and treat diseases in their livestock;
- training extension staff working with RPFs on animal health issues; and
- identifying research priorities in animal health for RPFs and initiating research projects. (J. Turton, pers. comm. 2000)

The other department involved is the Department of Molecular Biotechnology, which is mainly involved in research and diagnostics. Among the

research projects, those of interest include the development of a heat stable ND-DNA Vaccine and also a ND-Fowl Pox recombinant vaccine. These may be more suitable for use in the already well-developed and established commercial sector, but a cheaper alternative still needs to be found for village or rural poultry.

As far as diagnostics is concerned, the Department of Molecular Biotechnology has developed a polymerase chain reaction (PCR) diagnosis for ND, based on a publication by Kant et al.1997. This accords with the new definition of ND approved by the OIE International Committee, in the OIE working document on ND (OIE 2000), which states:

1. The virus must have an intra-cerebral pathogenicity index (ICP) in day-old chicks of 0,7 or greater.

Or

2. Multiple basic amino acids have been demonstrated in the virus (either directly or by deduction) at the C-terminus of the F2 protein and phenylalanine at residue 117, which is the N-terminus of the F1 protein. The term 'multiple basic amino acids' refers to at least three arginine or lysine residues between residues 113 and 116. (OIE 2000)

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# Country Report: Swaziland

T. Dlamini<sup>1</sup>

SWAZILAND is a land-locked country lying between 30°45' and 32°10' east longitude and between 25°40' and 20' south latitude. It is bordered by Mozambique and South Africa. Of a total human population of 929 718 (1997), 715 290 live in rural areas. In 1996, there were estimated to be 1 017 738 poultry in Swaziland.

## Newcastle Disease

Newcastle disease (ND) in Swaziland is now considered endemic, given the recent outbreaks. In 1994, there was a countrywide outbreak followed by sporadic occurrences up to 1998, when the country experienced another serious outbreak that was widespread. As a result of the 1998 outbreak, the Department of Veterinary and Livestock Services decided to evaluate and review the 1994 program.

The 1994 outbreak mainly involved free-range backyard poultry. A few commercial flocks which did not follow the standard control measures for the disease were also affected. The cause of the outbreak was the velogenic strain of ND virus.

Newcastle disease in Swaziland is a notifiable disease and as such the responsibility of its control falls under the Department of Veterinary and Livestock Services.

## Control program during the 1994 outbreak

There was a countrywide vaccination program mainly aimed at indigenous free-range backyard chickens. Farmers with commercial flocks were encouraged to continue with existing control programs.

The Department of Veterinary and Livestock Services was responsible for coordinating all the activities related to the vaccination program.

There were no enforced movement control measures. People were discouraged from moving their birds, and at times buses and cars were checked by the veterinary personnel.

Despite the best efforts of the Department to cope with the ND outbreak, there were a number of constraints:

- shortage of staff and transport to convey government personnel;
- homesteads inaccessible to government personnel;
- some farmers resisted the whole exercise;
- chickens incubating the disease were vaccinated and continued dying;
- late reporting of ND outbreaks allowing the disease spread rapidly;
- limited State funding;
- no properly designed movement control measures;
- no time to give booster vaccination;
- limited time for extension work; and
- farmers had limited information about the disease.

## Review of the outbreak

There was limited success in controlling the disease, evidenced by the fact that chickens throughout the whole country ended up being infected.

The following factors were identified as having contributed to the limited success of the control strategy:

- trade in live chickens occurred everywhere, i.e. next to the roads, between families and neighbours;
- sick chickens and those carrying the disease were mainly sold and that encouraged the fast spread of the disease;
- direct contact with infected chickens;
- chickens are among the cheapest gifts;
- general movement control of chickens was difficult, given their small size;
- veterinary personnel also contributed to the spread of the disease during the vaccination campaign;
- farmers had limited information about the disease with some suspecting that the veterinary personnel were responsible for killing their chickens;
- there was late reporting of the disease;
- limited resources; and
- shortage of personnel.

Given the above factors, the response from farmers varied. Some farmers resisted the whole

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exercise in the belief that the government's intention was to wipe out the remaining chickens, especially those adjacent to areas where birds started dying soon after vaccination. Others appreciated the exercise and were willing to work and cooperate with the government personnel.

#### **Current control program**

The current program is based on the above findings, and concentrates on farmer's education and proper management of ND.

#### *Education*

Information is spread through the electronic media, national newspapers, pamphlets, and agriculture newsletters. As well, there are workshops and seminars conducted by Veterinarians and Poultry Extension workers. Animal health courses are being taught in schools, colleges and universities.

#### *Management*

Properly designed movement control measures have been put in place, such as mounting road blocks and discouraging uncontrolled chicken trade during outbreaks of the disease. Chickens should never be moved from a suspected ND area to another. People are encouraged to report any sick and dead chickens to the Veterinary Department as soon as possible, and not to hide information about the flock. Farmers must demand vaccination history before purchasing any chickens, and not introduce any new chicken to their flock, unless proper history of the chick is known.

Farmers are also being educated about vaccine handling, management and application.

#### **Vaccination program**

Two vaccination strategies were formulated for backyard poultry. A short-term program was used consisting of a combination of live vaccination and

oil-based vaccine. The advantage of this combination being that:

- the live vaccine has a rapid immune stimulation effect but lasts for a short period; and
- the oil-based vaccine has a slow immune stimulation effect but the immunity lasts longer.

The long-term program is to routinely vaccinate following the short-term program, using mainly oil-based vaccines. Also a Commercial Layer program can be used for backyard poultry.

#### **Evaluation of the current program**

The program is gradually and positively achieving its set objectives, although with some minor limitations.

The advantages of the current program are that:

- it is farmer-driven, unlike the previous program which the farmers believed was imposed;
- the disease is now within bearable limits as only sporadic outbreaks are experienced;
- the limited department personnel are now mainly used for extension purposes;
- farmers are now buying the vaccine;
- farmers are continuously educated about the proper management and control of the disease;
- there is less risk of the disease spreading by the veterinary personnel; and
- there is less government spending.

#### *Limitations*

- there is less government control of the vaccination process as a result of inadequate data related to the disease and vaccination coverage;
- cold chain problem; and
- handling, management and application of the vaccine by the farmers need close monitoring and continuous education.

Given the nature of the disease a long-term regional approach in the control of ND has to be considered.

# Country Report: Tanzania

J.J. Buza<sup>1</sup> and H.A. Mwamuhehe<sup>2</sup>

TANZANIA has an estimated population of 30 million of whom 80% live in villages. The country has approximately 3.7 million agricultural households of which 2.5 million keep rural poultry compared to 1 027 383 who keep cattle (Minga et al. 1996). The country is endowed with vast poultry resources estimated at 29 685 220 birds, according to the 1994 livestock census. This number comprises 20 163 811 local village chickens; commercial chickens include 368 933 broilers and 152 478 layers. Other birds include 743 472 ducks and geese, 63 447 turkeys and 37 942 guinea fowls. These numbers fluctuate seasonally depending on a number of factors that include disease outbreaks, sales, and availability of feeds. Rural chicken supplies 100% of all the chicken meat and egg requirements for rural people and about 12–13% of urban requirements (Melewas 1989).

The major constraint to rural chicken development is Newcastle disease (ND). The disease causes 90% mortality rates and sometimes decimates whole flocks during outbreaks. Control of ND in rural areas is almost non-existent due to lack of an appropriate vaccine. Effective control of ND in village chickens will enable poor flock owners to realise the economic potential of this industry. Economic analysis of rural poultry in Tanzania indicated that it is a viable enterprise and a promising alternative source of income for rural households. It was calculated that with minimum input, a family stands to gain between USD 563–1000 per year, which is more than the per capita income (USD 130), as long as ND is controlled. Other workers estimated a national turnover of 114.9 billion Shillings (USD 144 million) from sale of growers if constraints such as ND are eliminated.

Conventional thermolabile vaccines have not been appropriate for village poultry because of their strict requirement for a cold chain. The advent of

thermostable vaccines from Australia has revived the possibility of controlling the disease in village chickens and current research efforts are focused towards the use of these vaccines. Initial studies on the thermostable vaccine strain NDV4-HR in the laboratory and the field produced very good results when the vaccine was administered intraocularly and via drinking water. Laboratory results using strain thermostable I-2 were similar to NDV4-HR. Since the last quarter of 1999, nation-wide field evaluation of thermostable I-2 vaccine has been going on. About 100 000 doses of the vaccine have been produced and are currently being distributed for evaluation to Veterinary Investigation Centres, located in the 7 agroecological zones of Tanzania. The trials are being coordinated by the Animal Diseases Research Institute (ADRI) in Dar-es-Salaam. The goal of the project is to bring the vaccine production closer to the villagers, and in packages (doses) equivalent to the number of chickens possessed by one or two flock owners.

## Village Poultry

Poultry play an important role in meeting economical and social obligations for the household, especially for poor families. In addition to slaughtering for home consumption, chickens are sold to raise money for the purchase of food, medicine, clothes and payment of school fees, bride price, farm implements, fertilisers, and levies. It is regarded as a special food during festivals, ceremonies, entertaining visitors and as a gift. Chickens are also kept for traditional healing and rituals.

Economic studies of rural poultry keeping have shown that the industry is a viable and promising alternative source of income for rural households. Salum et al (1999) calculated that a household with 10–15 chickens, at a reproduction rate of 3–4 generations per year and clutch size of 10–15 eggs, will generate an income of between 450 000 and 800 000 T. Shs. (US\$563–1000) per year. This is more than the 1997 per capital income of Tanzanians

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(US\$130). In a small study in the Morogoro region involving eight villages, it was observed that the ratio of chicks to growers to adults was 2:1:1 instead of the ideal 2:2:1, due to relatively minor constraints. With minimal inputs, these constraints can be eliminated resulting in a surplus of 76.6 million growers and an income of 114.9 billion shillings per year (Minga et al. 1996). Far more benefits can be reaped from this industry with improvement in management practices and genetic potential, which may result in increase in clutch size, generations per year and live weight.

### Village Chicken Production Systems

Village chicken management simply involves keeping birds under free-range and scavenging conditions around the homestead. The system is characterised by minimal inputs both in terms of time and resources.

Chicken management in the household is the responsibility of women and children. In most areas, men express little interest in chickens saying it is a lesser activity that is relatively unprofitable. However, in areas where chicken sales fetch higher prices due to demand by traders from big cities and towns, men become very much involved in keeping chickens.

### Housing

In many cases, chickens are provided with a night shelter within or outside the family's house. Usually a separate room is set aside for chickens within the house. Alternatively, chickens are sheltered in a kitchen that is separate from the family's living area, or a separate hut is constructed especially for chickens. The huts differ in shape and size from one region to another. In some areas, including the lake zone, poultry houses are raised up on poles to discourage predators. In others, a two-storey house is constructed where chickens and ducks are kept on

the ground floor and pigeons on the upper floor. Locally available materials are used for construction, such as mud bricks, or wooden poles plastered with mud and elephant grass roofing. In a few cases, the chicken huts are contained within a wire fence. The size of huts is often not adequate for the flock size, overcrowding is common, and usually ventilation is poor. Very few chicken owners allow chickens to roost on trees at night.

### Nutrition

Rural chickens obtain their daily ration mainly by scavenging around the homestead. Any supplementation they receive can include maize grain, maize or sorghum or millet bran and human table leftovers. Addition of protein is rare except when children catch insects or worms and feed the chickens as a hobby. Water is also provided by a number of farmers. A few flock owners provide feeding and watering facilities. These are not specialised but are in the form of broken mugs, gourds or wooden troughs.

### Breeds/types

A number of chicken breeds are kept in the Tanzanian traditional chicken production system. These types vary in size, hatchability, number of eggs laid and mothering ability. There is normally no selection process practised. The characteristics of the different breeds are shown below. The names of different breeds and types differ from one area to the other; the breed names shown in Table 1 are adopted from Southern Tanzania.

### Constraints to the Production of Village Chickens

Very few studies have been undertaken to identify production constraints affecting the rural chicken industry. Diseases are the greatest problem affecting

**Table 1.** Characteristics and features of different breeds of chicken in Tanzania.

Breed/Type	Characteristics/features
Kuchi or Kuza	Short beak with few feathers, heavy with good meat, lays few eggs (7–10) but usually hatches them all, 4-months laying interval, mature size big, much preferred due to its size and weight
Poni or Kishingo	Small in size, less weight, many feathers, lays up to 20 eggs and hatches them all, good mothering ability, 4-months laying interval
Mbuni	Moderately big in size, no tail, lays up to 15 eggs and hatches them all, laying interval between 3–4 months, more vulnerable to diseases
Tongwe or Msumbiji	Short and stout, small in size and weight, lays about 20 eggs and hatches them all, good mothering ability, preferred by producers but not buyers because of small size, laying interval between 3–4 months

village chicken production (Melewas 1989; Minga et al. 1989). In a survey of rural poultry keepers by Yongolo (1996), respondents ranked constraints in the following order; diseases (95.5%), ectoparasites (88.8%), predators (82.2%), lack of affordable veterinary services (73.3%), stock theft (60%), lack of marketing services (55.5%), control of prices (51.1%), housing (40%), feeding/watering (22.2%). Of the diseases, ND was by far the major problem cited by villagers. Other diseases were fowl typhoid, pullorum and coccidiosis. There are probably many other diseases that were not mentioned by respondents, such as helminthoses as they do not usually cause massive deaths.

### **Epidemiology of Newcastle disease**

Not many studies have been done in Tanzania to assess the epidemiology of the disease in village chickens. However, based on available information, the disease has been reported in all regions of Tanzania, affecting all age groups and causing high mortality rates, sometimes up to 100%. General information from various Veterinary Investigation Centres located in various parts of the country and from interviewing flock owners, indicate that disease outbreaks occur mainly in the dry season (July–November). However, due to poor disease reporting and documentation, these Centres do not have hard data to confirm this seasonality.

In 1998 the Ministry of Agriculture established a disease reporting system whereby Village Extension Workers are required to fill in field report forms for every disease outbreak encountered. The Epidemiology Unit at the Ministry headquarters places the information obtained onto a computer database, which is accessible on demand. According to this database, ND outbreaks in 1998 and 1999 were 24 and 84 respectively. No seasonal pattern was discernible. According to the Epidemiology Unit, so far only about 10% of cases are reported because the system is still new. In addition, the accuracy of these reports is questionable due to lack of qualified personnel and lack of diagnostic facilities at the village level. However, it is hoped that as the reporting system improves and Village Extension staff receive training on identification of diseases and diagnostic facilities get closer to villages, reliable information will start emerging from the database.

Yongolo (1996) did a detailed cross-sectional study on the epidemiology of ND disease in the Tabora and Morogoro regions. The overall seroprevalence was 37.2%. However, in both regions, highest seroprevalence rates were found in September–October (63.5%), followed by March (50%), July (25%), December–January (19.1%) and lowest in June

(18.1%). The mean haemagglutination inhibition (HI) titres were highest in September–October ( $\text{Log}_2$  4.4) and lowest in June ( $\text{Log}_2$  1.21). Severe ND outbreaks were reported and confirmed in June–October while minor outbreaks occurred in December and February. These data confirm the seasonal occurrence of ND in the dry season between July–November. However, it seems this seasonality is determined on the basis of relative severity and frequency of outbreaks. Outbreaks can still occur at any time of the year depending on availability of susceptible populations and virulent virus. In addition to the season, the study by Yongolo (1996) identified other risk factors associated with ND. These include location (village, region), age, presence of other poultry species (ducks, pigeons) and proximity of homesteads.

### **Diagnosis of Newcastle disease**

At village level, diagnosis of ND depends entirely on clinical signs. The main signs are high death rates and drooping of wings. Very few cases are submitted for laboratory diagnosis because of distance and other logistical problems. The recently introduced field report form, that reports and describes any disease outbreak, will supply the much-needed information. However, at present the flow of report forms from villages to the Veterinary Investigation Centres has been sluggish because the mechanism has not been streamlined.

### **Methods of control of poultry diseases in village chickens**

#### *Traditional methods*

Various traditional medicines have been claimed to treat ND in village chickens, but their efficacy has not been confirmed in controlled laboratory studies. Some of these remedies are listed below:

- *Pilipili* fruit (pepper): Red pepper powder is mixed in drinking water or is given orally.
- *Osukuroi* leaves (*Aloe* spp.): Leaves weighing about 0.25 kg are sliced into fine pieces and mixed with three cups of water and mixed thoroughly and left to stand for few minutes. This is given orally. However, *Osukuroi* is said to be toxic so care should be taken not to exceed the recommended dose. Recovery is claimed to occur after 3 days
- *Capsicum* spp.: Fruits of capsicum and pieces of unripe pawpaw fruits are steeped in water and the mixture given as a drench to birds.
- *Lonzwe* (*Cupharia* spp.), *Swiswi magandaga* (*Cissus quadrangularis*) and *Nkulwamhembe*: A mixture of water and stem material from *Lonzwe* and *magandaga* and root material of *swiswi* and

nkulwamhembe. It is given orally and is claimed to be 100% effective.

#### *Conventional methods*

The conventional method available for control of ND in rural poultry is the use of ND vaccines, but this method is not often used. Very few flock owners vaccinate their flock against ND or against any other disease. The few people who do vaccinations in some villages include village extension personnel and teachers. Most flock owners sell or slaughter their chickens when the disease outbreaks begin.

### **Role of Extension Services in Village Chicken Production**

The government, through the livestock extension field officers, is currently running a unified extension services, including livestock and crop production at village level. But with the advent of economic liberalisation, the private sector will take over some of the government functions. The role of the government will be limited to the control of epidemics, infectious diseases, sanitary control, regulation and eradication of scheduled diseases. In vaccination programs, the government will retain the role of controlling the quality of vaccines. It will support and promote the private sector to import and distribute veterinary inputs and establish an effective regulatory and marketing system for products. It will, however, take a long time for private sector services to reach the village level, as most private practitioners are concentrated in cities and towns. Meanwhile, mechanisms should be set up to facilitate the participation of NGOs and community-based groups to fill the gap.

#### **Institutional and human resource capacity**

The following shows the number of personnel in the animal health delivery sector:

Registered veterinary surgeons	414
Government Officers:	
Veterinary surgeons	173
Livestock officers	67
Livestock field officers	1437
	(certificate and diploma)

Other institutions involved include:

Parastatals  
Sokoine University of Agriculture      Involved in research

NGOs (AUSTROPROJECT, VETAID, Religious): these assist in providing communities with sustainable animal health services, loans, training, water and marketing of livestock products.

#### **Marketing**

There is currently no established formal marketing system for rural poultry. However, there is an increasing demand for village poultry meat in towns and cities, which has created a group of traders who travel to villages to purchase the birds. Because of relatively high demand as compared to supply, all the available birds are taken up and therefore no marketing problems have been encountered

### **Research and Development on Rural Poultry Production**

Research into village chickens has not previously been the object of many studies. Since the advent of thermostable ND vaccine, a number of projects aimed at evaluating these vaccines under Tanzanian conditions have emerged. The main impetus on research on village poultry has focused on ND because it is the major production constraint.

Laboratory trials performed at Sokoine University of Agriculture revealed that the NDV4-HR vaccine administered via the intraocular route and drinking water provided high levels of protection against challenge with Newcastle virus up to 90 days post-vaccination, with no side effects observed. Following successful laboratory trials, field trials to assess the efficacy of NDV4-HR vaccine under village conditions were done. Results from studies in Central Tanzania (Foster et al. 1996) and Southern Tanzania (Salum and Kapaga 1997) confirmed laboratory findings that NDV4-HR conferred a high level of protection when administered intraocularly and via drinking water. The usefulness of the vaccine when administered through feeds such as sorghum is questionable.

Another thermostable vaccine the Australian strain I-2 was tested at ADRI laboratory and the results obtained were comparable to those of NDV4-HR (Wambura et al. 2000).

A nationwide project aimed at production and testing of the Australian strain I-2 vaccine started recently. The vaccine is produced at ADRI and is distributed to six Veterinary Investigation Centres located in different agroecological zones of Tanzania. An identical protocol is used for testing of the vaccine in selected villages.

It is obvious that research on village poultry should also focus on other diseases and husbandry such housing and nutrition. When the present genetic potential of village chickens is realised, a decision on whether or not to improve genetic composition can be made. Finally, there is need for the formation of a network on all activities related to poultry so as to coordinate research and extension activities.

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# Country Report: Zambia

A. Songolo<sup>1</sup> and J.C. Katongo<sup>2</sup>

POULTRY contribute greatly to the protein requirements of the rural population and also to the income generating power of the family. It has been recognised that households with both livestock and crops as their sources of income are better able to cope with the effects of drought and devastating cattle diseases that reduce animal draught power. Newcastle disease (ND) is the main limiting factor in rural poultry production systems. The disease, first reported in 1952, was originally concentrated along the line of rail where the largest concentration of birds occurred. There was a definite correlation between the number of outbreaks and the amount of vaccine used in any one year.

With the introduction of the private sector into the provision of vaccine and increased extension in these areas, the incidence of ND along the line of rail has greatly reduced and the highest number of reports is now from the rural areas. The education of traditional farmers on poultry husbandry, the availability of a vaccine not requiring a cold chain and that is easily applied to small flocks, will greatly reduce the incidence of this disease. The control of this disease in rural settings will greatly increase the productivity of village chickens and the benefits this generates. Through the provision of free extension services and the provision of micro-credit, the Zambian government is committed to increasing poultry production in rural areas.

Zambia's population is currently estimated at some 10 million people. Sixty five per cent of this population lives in urban centres where employment opportunities have become scarce and social infrastructure inadequate. The balance of the population that lives in the rural setting is mostly occupied with subsistence farming, fishing, logging and small-scale trading. There are few industrial activities away from the main urban centres, along the line of rail.

Official estimates put current land utilisation for agriculture activities at below 20% of the arable land available. Of this 75% is used by small-scale farmers (85% of farmers) while the remaining 25% is used by the commercial farmers (15% of farmers).

Zambia has vast tracts of land (forests and plains) that are ideal for livestock farming that is concentrated in the central, southern, eastern and western regions of the country. The livestock sector comprises 2.6 million cattle, 500 000 goats, 75 000 sheep and 300 000 pigs. Poultry production is estimated at around 12 million broiler birds, 3 million commercial layers and 11 million village chickens.

## Village Poultry

The poultry industry in Zambia is based on two distinct systems. The first is the commercial system where broilers are obtained from hatcheries and reared for six weeks on commercial feed and in properly designed chicken runs. The commercial system is mainly along the line of rail in close proximity to the major towns. The second is the village system where chickens scavenge for food and take an average 20–22 weeks to reach maturity. These birds obtain food from the village environment and often they must find their own sources of water. However, some owners do supply drinking water close to the house. They also sometimes receive supplements in the form of household scraps or crop by-products.

The standard of housing varies greatly. Village chickens spend the nights either in the family kitchen, a run made of straw, or roosting in trees. Structures are usually small and low to prevent thieves and predators gaining access to the poultry.

Village chickens in Zambia are not homogenous and are impossible to monitor. Little information is available on local breeds, but the use of special names for them in local languages indicates that they represent fixed types with recognisable and distinguishing characters. Generally, the small dwarf breeds with naked necks are found in the valley areas

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of the Zambezi and Luangwa Rivers. The plateaus have a slightly larger bird. The adult weight of village birds averages 1.2 to 1.5 kg live weight attained at 22 weeks of age or later. Village chickens lay on average 70 eggs per year that weigh 40–42 g. The birds brood 7–18 eggs at a time. Hatchability is 85–90%. Mortality is high, with 55% of chicks dying due to predators (dogs, cats, and wild birds), nutritional deficiencies or disease.

The poultry industry system is largely in the hands of women and children. Although ownership is by both women and men, it is the women who ensure that the birds are tended. It is also the women who decide which bird is to be sold or slaughtered. Village chickens fetch a premium price in Zambia.

Traditionally cattle are the livestock with the most cultural and economic significance. Poultry are generally ranked below ruminants. When considering the different types of poultry, however, chickens are preferred to guinea fowl, turkeys, ducks or pigeons. Poultry not only provide important sources of animal protein but are also considered as assets that can easily be converted into cash. They are often sold or bartered in response to household or farming needs. The requirement for schoolbooks or fees at the beginning of the school year triggers such sales. Most social occasions are marked by the slaughter of chickens (the arrival of important guests, cultural festivals etc). Chickens are also used to pay for minor misdemeanours and feature prominently in local rituals.

The constraints to the production of village chickens include inadequate housing, nutritional deficiencies, predation and disease. Newcastle disease has been identified in Zambia as the leading killer of village chickens, followed by worm infestation, mycoplasmosis, parasitic (external) infections and coccidiosis.

### **Epidemiology of Newcastle Disease**

The disease was first reported in native fowls in Zambia in Mazabuka, the Southern Province, in May 1952. By 1957, it had spread to the major poultry producing areas of the country. Previously, the largest number of outbreaks was always recorded in Central Province followed by Southern and Copperbelt Provinces. This has now altered with the highest number being in North-western Province followed by Eastern and then Southern Provinces. The reasons for the change have been the demarcation of Lusaka Province from Central Province in 1976, increased availability of vaccine in the 1990s in urban areas, and the education campaigns by both government extension staff and the private sector.

Most outbreaks are in the traditional sector. The disease is enzootic in the rural areas. The difference in disease incidence between the traditionally and commercially managed flocks is explained by the differences in vaccination and husbandry practices followed under these two management systems. A survey conducted by the Central Veterinary Research Institute (CVRI) in 1991 on the vaccination coverage in the Copperbelt and Lusaka Provinces showed that only 10% of the traditional farmers vaccinate. The cold chain required to properly vaccinate against ND reduces vaccination opportunities among village flocks.

Although reports come in all year round there is slight peak in the months of January to March and September to November. There are two schools of thought as to why this is so. September to November is a hot dry season with increased wind flow throughout the country. January to March is cool and humid with heavy rains. Both seasons are thought to favour the airborne transmission of the virus (Sharma et al. 1988). The second school of thought believes that the peaks are due to both climatic and social factors, i.e. extensive travelling to visit friends carrying live chickens, and the need in January for cash to meet school fee requirements (J.C. Katongo, unpublished data). Other factors associated with the transmission of Newcastle disease are the exposure to the natural environment and the keeping of flocks of various ages.

All isolates from field outbreaks have been identified as virus strains of the viscerotropic, velogenic pathotype. Mortality is usually high, ranging from 70–100%.

The methods used in the diagnosis of ND are haemagglutination (HA), haemagglutination inhibition (HI) and egg inoculation. The results obtained at CVRI are communicated to the veterinary field services, which institute measures of disease control.

### **Control Measures**

It is a statutory requirement that all suspected cases of ND be reported to the office of the Department of Animal Production and Health. Legislation stipulates that once the laboratory confirms the presence of the disease, a ND infected area is declared. The infected area normally covers a radius of 20 kilometres around the outbreak area. Regulations remain in effect for two months following the last confirmed outbreak. Movement of all avian species in and out of the infected area is forbidden. The policy of government is to enforce vaccinations, with farmers paying for vaccinations. The government stopped providing free ND vaccine in 1978 due to financial

constraints. The cost of the vaccine is USD2 per 1000 birds.

The commercial hatcheries vaccinate day-old chicks using Hitchner B1 by intranasal or eyedrop routes. Farmers are advised to revaccinate boilers at 7 and 21 days with La Sota vaccine or Clone 30. Layers are revaccinated at 10 weeks of age. In village flocks, vaccination is limited due to various reasons, which include: lack of proper storage and cooling facilities at village level; low concentration of chickens per village (30 to 60 chickens); multiple ownership of chickens within village flock; unavailability of the vaccine; and inadequate extension services.

Both conventional and traditional remedies are used in the treatment of ND at village level. During a survey carried out in 1991 by CVRI and the University of Zambia it was found that 39% of farmers used traditional medicine and 14% used conventional medicine (amprolium and tetracycline being the most common).

Almost all medicines were administered via drinking water. Traditional methods include the following trees and plants (in general leaves and stalks are added to drinking water): *Agave sisalana*, *Aloe* species, *Apodytes dimidiata*, *Cassia obtusifolia*, *Cissus quadrangularis*, *Capanifera baumiana*, *Diplorhynchus condyocarpus*, *Droogmansia pteropus*, *Swartzia madagascariensis*, *Euphorbia tirucalli*, *Ficus* species, *Imulia glomerata*, *Isobertinia anglonensis* and *Kigelia africana*. The two main exceptions are that of the roots of *Droogmansia pteropus* and the bark of *Swartzia madagascariensis* were used occasionally and not the leaves.

No work has been done to evaluate the efficacy of these remedies.

### Poultry in Households

Rural poultry is an important element in diversifying agricultural production and increasing household food security. Cattle are rarely slaughtered for home consumption unless for the funeral of a rich man (Southern Province of Zambia) or for an important festival such as a wedding. Therefore, an increase in cattle numbers translates only minimally into an increase in the availability of animal protein or cash. Chickens, however, are readily slaughtered on many occasions depending on the availability.

The Southern Province of Zambia has in recent years been devastated by both drought and the cattle disease theileriosis, which has decimated draught power. A small study found that households with chickens were more able to survive the drought and recover the following year than households without chickens.

The Government of Zambia, in conjunction with cooperating partners such as German Technical Assistance and the International Fund for Agricultural Development, are supporting local cooperatives with financial assistance so that they can improve their agricultural production. Amounts of up to USD2500 are lent to cooperatives for agriculture-related activities. It has been found that in groups made up entirely of women poultry production is the most favoured activity.

**Table 1.** Four districts showing number of poultry projects/women's groups.

District	Total no. of groups	Women's groups	Poultry loans
Choma	87	18	34
Monze	12	5	3
Mazabuka	12	1	0
Siavonga	41	5	2

It appears that women prefer poultry production as it easily fits in with their other duties around the homestead. The benefits of owning chickens are also appreciated.

Both non-governmental organisations and government are carrying out extension services. For poultry-raising to be truly sustainable, the government must ensure that it is village chickens that are kept by these farmer groups and not commercial flocks in a village setting.

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# Country Report: Zimbabwe

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POULTRY meat is an important source of animal protein in the rural areas of Zimbabwe. Almost every household in rural areas owns indigenous chickens. The village poultry production system can be described as one of low input in terms of feed and veterinary costs with considerable output in the form of eggs and meat. A rigorous economic study on the village poultry production system is still to be undertaken. Although the importance of village poultry may be low compared to other stock like cattle, sheep and goat, ranking in terms of profitability may not necessarily place poultry as the lowest.

## Village Poultry Production

The indigenous bird is mostly free-range although there is confinement in the rainy season during planting. The production system is largely subsistence with very limited sales of birds or eggs. The average flock size is 20 birds consisting of one cock, four hens, seven growers and eight chicks. On average, a hen lays about 38 eggs per year. Village poultry is generally less productive compared to the exotic commercial birds.

The village chicken has a dual-purpose, and is selected and raised for meat or egg production. The indigenous birds vary considerably in size, colour, shape of comb and other features. In the eastern parts of the country, the naked-neck variety, which is also a large bird, is commonly seen. Very small bantams are found throughout the country, and there are also some varieties with short and bowlegs. Generally, the naked-neck variety is favoured for its size and good mothering.

The indigenous birds range freely in search of food, with about 85% of farmers providing no supplementary feed. Where supplementary feed is given, it varies, depending on the time of the year and type of crops grown locally. Generally, cereal grains, including maize, millet, rapoko, sunflower,

sorghum, and 'sadza' prepared from the local grains, are the main supplement. Supplementation is implemented at specific periods like during the planting season and during chick rearing. In some communities, chicks are removed from the mother and kept in confinement where they are fed maize meal and whole cereal grains. Some households also provide vitamin and mineral supplementation for the chicks. One of the main reasons for confining the young chicks is to prevent predation by birds of prey like eagles and crows. In a socioeconomic study of 280 households, it was found that 98.3% of farmers provide water for their birds in the dry season, while 95.6% did in the wet season.

The same study found that more than 90% of households provide housing for the chickens. The type of housing does vary and includes fowl run, kitchen, main house and woven basket. The study also found that 3.3% of the households did not provide any accommodation and so birds had to perch in trees at night. The fowl runs, which are the commonest type of housing, are built from various materials like bricks and poles, and roofed using asbestos, corrugated iron sheets or thatched with grass.

Women play a pivotal role in village poultry production while men concentrate on other livestock like cattle, sheep and goats, or may work in urban centres. Between 55% and 65% of the chickens are owned by women. The main activity of women includes assistance during brooding and cleaning the fowl run, while men dominate the provision of supplementary feeding. Building of fowl runs, and opening and closing fowl runs are mixed duties where all members of the family participate. Although poultry are primarily women's responsibility, some 25% of women cannot make production decisions alone. About one third of poultry is owned communally within the household.

Poultry play a key role as both a source of high protein food and income, and often as a source of garden manure. Input costs are among the lowest compared to other enterprises like cattle, sheep or

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goat. Poultry have the fastest turnover and require limited land area.

#### **Cultural importance of village poultry**

There is a considerable amount of trade, gifting and exchange of poultry in the rural areas. Traditional healers request a live bird as consultation fee in some cases. Chickens are also very useful for barter in exchange for goods like grain. Chicken dishes are always served during traditional social functions, especially those involving in-laws. In some rural communities the black chicken is used to exorcise evil spirits.

#### **Constraints to village chicken production**

Some of the constraints to village poultry production include: poor management (nutrition and housing); disease, inadequate extension; and lack of credit facilities. It was observed in a study that only 15% of interviewed poultry owners gave supplementary feed. In the same study, about 55% chick mortality was recorded and nutritional stress was suspected as one of the most likely cause in that age group. The relatively low annual egg production of about 38 per hen could be explained in part by a low level of nutrition. A significant number of chicks fall prey to eagles, squirrels or snakes when they are not housed or the housing is poor. Disease is another constraint and important diseases include Newcastle disease (ND), infectious bursal disease, infectious coryza, fowl pox, coccidiosis and parasitosis (external and internal). Limited poultry health extension was confirmed when 44% of women interviewed felt they did not have the skills to treat their birds. Availability of credit was considered by 73% of the women interviewed to be necessary for improved poultry production. Credit was needed for construction of good poultry houses, wire mesh fencing and purchase of feed and veterinary medicines.

#### **Newcastle Disease Control**

Currently the Department of Veterinary Services continues to control ND by ring vaccination in response to outbreaks. Vaccines currently used include NDV4-HR, La Sota and Immopest. Following the implementation from 1996 to 1998 of the FAO Technical Cooperation Programs Emergency Assistance for the Control of Newcastle Disease TCP/ZIM/4553 and TCP/ZIM/8821, establishment of a community-based approach to ND control was emphasised. Farmers were taught how to deliver the NDV4-HR vaccine using eyedroppers. Routine vaccination for ND has become the responsibility of the poultry owner, while the Department stocks the vaccine throughout its

network of Provincial, District Offices and Animal Health and Management Centres. The vaccine is provided free now. Other control strategies include quarantine and movement control.

Some households interviewed during the socio-economic study reported that they used crushed aloe as a broad-spectrum remedy for most poultry diseases. Snuff (tobacco) was used for control of fleas. Parasites in the poultry house were controlled through burning, where asbestos or corrugated iron sheets were used for roofing.

#### **Epidemiology of Newcastle Disease**

ND is probably the most feared disease of poultry throughout the world, and the disease has spread to all continents in recent decades. Zimbabwe has had limited outbreaks of ND, apart from the major outbreaks of 1994. There have been three limited outbreaks, the first in 1957 along the border with Zambia, and in 1975 and 1986 along the border with Mozambique. On all occasions strict quarantine, movement control and vaccinations quickly controlled the disease. The worst epidemic of ND in Zimbabwe started in December 1993 in Sengwe communal area of Chiredzi district along the border with South Africa. By June 1994, the disease had affected most of the communal areas of Masvingo province. Because of the complexity of rural movements, control of poultry movement ceased to be effective as a means of controlling the disease. Three months later, the disease had spread to most provinces making vaccination the only logical control strategy.

The Department mounted vaccination campaigns using La Sota eye drop and injectables like Immopest or Newcavac Nobilis concurrently. Birds vaccinated were ten million in 1994 and six million in 1995, all in the communal sector. ND has largely been a disease of the rural backyard flocks. Few outbreaks were experienced in the commercial sector due to the strict bio-security and routine vaccinations. In 1995 out of a total of 172, outbreaks, only 14 (8%) were reported from commercial flocks. None of these was large commercial producers who had good bio-security and zoo-sanitary controls. During 1996, no commercial flocks recorded outbreaks of ND and the 21 outbreaks reported were all in back yard rural poultry. Table 1 shows the annual occurrence of ND and vaccinations by the Department of Veterinary Services (DVS) in the communal areas.

During the period 1994 to 1999, a series of epidemic cycles occurred coinciding with periods of highly susceptible bird populations. The hatching period peaked in June while in other areas continued

through until September and October. The high proportion of very young birds from June to October could explain the epidemic peaks during these times of the year. The cost of vaccine delivery in the communal areas was such that vaccinations could not be sustained every four months to keep the susceptible population low. The need to maintain a cold chain during delivery made it impossible to hand over vaccination to the poultry owners in the communal areas. From the socioeconomic study, transfer and movement of birds between villages and regions are quite common enabling owners to use them for celebrations, gifts, for barter trade and as ready sources of cash. This considerable uncontrolled movement of birds does contribute to the spread of infection.

**Table 1.** Annual occurrence of ND and vaccination of rural poultry by DVS.

Year	No. of ND outbreaks	No. of birds vaccinated
1994	281	10 000 000
1995	172	6 000 000
1996	21	215 800
1997	64	371 600
1998	80	3 837 400
1999	8	417 000

Only nine out of some 250 ostrich flocks were affected by ND since the beginning of the outbreaks in 1993. Apart from the affected properties, no ostrich properties have vaccinated against the disease, leaving the vast majority of ostriches in Zimbabwe unvaccinated.

### Diagnosis of Newcastle Disease


ND is a notifiable disease, which means that any person is required by law to report the disease, whether confirmed or suspected, to the veterinary authorities. Disease surveillance is implemented through a network of eight provincial offices, 58 district veterinary offices and 320 animal health and management centres (AHMCs). A standard form (Figure 1) was developed for disease reporting. The AHMCs are confined to the communal resettlement and small-scale farming areas. Staff are required to report suspected ND within 24 hours to the Epidemiology Unit of the Field Branch. Based on post-mortem findings and epidemiology, a provisional diagnosis is made and control measures are initiated. Samples which include trachea, cloacal swabs, lung, brain, spleen, liver, kidney and bone marrow are collected and sent to the Central Veterinary Laboratory (CVL) in Harare by courier service for confirmation.

The objective in the diagnosis of ND is to reach a decision on whether or not to implement control measures. Neither clinical signs nor post-mortem lesions of ND are pathognomonic due to the wide variation in virus strains, host species, immune status and other factors. Similarly the presence of lentogenic ND virus (NDV) strains in birds in most countries and the almost universal use of live vaccines means that mere demonstration of infection, such as the presence of NDV in a host, without characterising the infective virus is inadequate. Of particular importance in the diagnosis of ND is that it may cause severe losses and have adverse effects on trade in poultry and poultry products such that control measures are usually defined at national or international level.

In Zimbabwe, laboratory diagnosis of ND is based on virus isolation in 9 to 11 day-old embryonated chicken eggs from breeder flocks. The embryonated eggs should ideally come from an unvaccinated flock free from NDV infection. Since the egg supply to the Virology Section of the CVL is from a ND vaccinated flock, there exists a risk of antibody interference with virus isolation. Care is taken to avoid rupture of the yolk sac, which contains antibodies that could contaminate the allantoic fluid leading to neutralisation of virus. It is important that the eggs are well chilled at 4 degrees Celsius for six to twelve hours before harvesting the allantoic fluid to reduce the risk of erythrocyte contamination of the fluid. After virus isolation haemagglutination (HA), haemagglutination inhibition (HI) and mean death time (MDT) are performed for characterisation of the virus. The virus isolation method is based on that given in A Laboratory Manual for the Isolation and Identification of Avian Pathogens, Third Edition, 1989, and the OIE Recommended Diagnostic Techniques and Requirements for Biological Products, Volume 1, 1989.

### Extension Services

Extension services working with rural poultry in Zimbabwe include those departments under the Ministry of Lands and Agriculture, namely: Department of Veterinary Services (DVS); Department of Agricultural and Technical and Extension Services (AGRITEX); and Department of Research and Specialist Services (DRSS). Non-governmental organisations also provide extension services in the villages. DVS mainly provides extension in poultry health while AGRITEX and DRSS provide extension in poultry husbandry. Through its network of 320 AHMCs, the department's Veterinary Extension Assistants (VEAs) are responsible for disease investigation and advice on poultry disease control.



## DEPARTMENT OF VETERINARY SERVICES

FIELD, EPIDEMIOLOGY AND EXTENSION REPORT

**SHADED BOXES  
MUST BE COMPLETED**

<b>PROVINCE</b> <input style="width: 100%;" type="text"/> <b>OWNER</b> <input style="width: 100%;" type="text"/> <b>FARM ADDRESS/ DIP TANK</b> <input style="width: 100%; height: 20px;" type="text"/> <input style="width: 100%; height: 20px;" type="text"/> <b>DISEASE</b> <input style="width: 100%;" type="text"/> <b>Disease Code (if listed over)</b> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/>	<b>DISTRICT</b> <input style="width: 100%;" type="text"/> <b>STATION</b> <input style="width: 100%;" type="text"/> <b>YOUR REF</b> <input style="width: 100%;" type="text"/> <b>GRID REF</b> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/>
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**FOLLOW UP REPORT?**  
*(of previously reported outbreaks)*  
**TICK**  **YES**  **NO**

DATE OF DIAGNOSIS	SPECIES	EPIDEMIOLOGY			DISEASE CONTROL		
		NUMBER			NUMBER		
		At Risk	Of Cases	Of Deaths	Treated	Vaccinated	Other

<b>TICK as appropriate</b> <b>DIAGNOSIS</b> laboratory clinical pm suspect	<b>CONTROL</b> vaccine treatment quarantine dip other none	<b>SECTOR</b> commercial communal small scale resettlement other	<b>AFFECTED POPULATION</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;"><b>SEX</b></td> <td style="width: 15%;"><b>AGE</b></td> <td style="width: 25%;"><b>SYSTEM</b></td> <td style="width: 45%;"></td> </tr> <tr> <td>male</td> <td>neonate</td> <td>dairy</td> <td>(cattle only)</td> </tr> <tr> <td>female</td> <td>&lt;6 mo</td> <td>beef</td> <td></td> </tr> <tr> <td>castrate</td> <td>6m-1yr</td> <td>mixed</td> <td></td> </tr> <tr> <td>all</td> <td>adult</td> <td>other</td> <td></td> </tr> <tr> <td></td> <td>all</td> <td></td> <td></td> </tr> </table> <p style="text-align: right; margin-top: 10px;"> Wildlife involvement in transmission? <input style="width: 40px; height: 20px;" type="text"/> <b>YES</b> <input style="width: 40px; height: 20px;" type="text"/> <b>NO</b> <input style="width: 40px; height: 20px;" type="text"/> <b>?</b> </p>	<b>SEX</b>	<b>AGE</b>	<b>SYSTEM</b>		male	neonate	dairy	(cattle only)	female	<6 mo	beef		castrate	6m-1yr	mixed		all	adult	other			all		
<b>SEX</b>	<b>AGE</b>	<b>SYSTEM</b>																									
male	neonate	dairy	(cattle only)																								
female	<6 mo	beef																									
castrate	6m-1yr	mixed																									
all	adult	other																									
	all																										

Comment on 'other' marked above

Main clinical signs/ post mortem findings:

Comment on epidemiology: (source, rate of spread, vectors, reservoirs)

Signature: \_\_\_\_\_

**POSITION**  
(tick) 

VET	AHI
VEA	LAY

NAME \_\_\_\_\_

Figure 1. Disease field report form.

Meetings, field days and shows are also conducted to disseminate information. Extension packages (leaflets and manuals) are produced by all the service departments according to needs, and in collaboration with farmers through Participatory Rural Appraisal (PRA) techniques.

### **Potential for Village Chicken Production**

Village chicken production has great potential if the constraints to production are alleviated. Improvement in health management would prevent the high chick and grower mortality that has been observed. Since 81% of farmers interviewed had no training in poultry management, a lot could be achieved with training. Given that women are the major stakeholders, there may be opportunities for extension workers to work in collaboration with key local women or women's groups. Predators contribute significantly to poultry losses and with good housing the problem could be alleviated.

### **Institutional and Human Resource Support**

DVS staff which interact with village poultry producers include 85 veterinarians, 91 Animal Health Inspectors (AHIs) and 275 Veterinary Extension Assistants (VEAs). More than 1500 Extension Workers from AGRITEX and eight Specialist Officers from DRSS also provide extension and training to the villagers. DVS and AGRITEX extension workers are housed at the same offices hence they complement each other in service delivery. Specialists from the DRSS are mainly involved in research and the technologies and knowledge acquired is passed on the extension agents in DVS and AGRITEX for dissemination in a language suitable to the farmers. NGOs working in particular project areas are also involved in training farmers usually in conjunction with DVS and AGRITEX staff. There is very limited private sector involvement in the rural areas except for a few veterinarians working in their private capacity. Recently an

Agricultural Training Institute was dedicated to communal farmer training, and courses include poultry production.

### **Marketing of Poultry**

In a survey carried out, communal farmers preferred indigenous chickens for their good taste to the improved broilers on the market. Hence, the indigenous chicken is well received by communal farmers and the only obstacle is the failure to meet demand due to the current low productivity. Opportunities exist in the rural areas through local butcheries, hospitals and schools, all demanding large quantities of chickens that at present could not be fulfilled by the farmers. In fact, marketing was not perceived as a problem by 70% of farmers.

Currently, marketing is limited to live birds and, because of the small numbers involved, there are no problems being faced. There is virtually no trade in eggs or meat of indigenous chickens at the moment.

### **Research and Development**

The Department, through two FAO TCPs (TCP/ZIM/4553 and TCP/ZIM/8821) carried out research into the possibility of delivery of the NDV4-HR vaccine through locally available grains. Although rapoko was the best vaccine vehicle, challenge of birds after six vaccinations produced unacceptably low protection. Hence, feed-based vaccine delivery was considered ineffective. During field trials, the NDV4-HR and I-2 strains produced good protection, more than 90% when given by eye drop method.

Socioeconomic studies conducted yielded valuable information on rural poultry husbandry, health constraints and flock dynamics. As a result, extension packages are being produced to address some constraints to rural poultry production.

The Department of Research and Specialist Services is currently conducting studies on the performance of indigenous birds under deep litter system and with improved feeds.



# The Epidemiology of Newcastle Disease in Village Chickens

P.B. Spradbrow<sup>1</sup>

## *Abstract*

Newcastle disease virus (NDV) infects most avian species. The serious consequence is the disease (frequently fatal) that occurs when virulent strains of the virus infect domestic chickens. The epidemiology of Newcastle disease (ND) in commercial chickens is fairly well understood. Infected chickens are the usual source of virus, which can be transported mechanically by fomites or by people. Preventive measures include vaccination and attention to biosecurity. Village chickens are also susceptible to ND, which, in developing countries, is the most important constraint to rural poultry production. Similar epidemiological factors probably apply to the spread of NDV in commercial chickens and village chickens. Until recently, thermostable ND vaccines were not available for use in village chickens. Biosecurity is extremely difficult to practice at the village level. Both epizootic and enzootic ND are recognised in village chickens. Epizootics occur when virus is introduced to a susceptible population. Spectacular outbreaks with high mortalities result. Enzootic ND occurs when the virus transmits slowly in a partially immune population. In this case, there are too few susceptible birds to maintain an outbreak and the occasional birds that die do not come to veterinary attention. Possibly a breeding population of as few as 500 birds can sustain the virus, as indicated by computer modelling. Anecdotal evidence suggests that seasonal conditions favour the initiation of outbreaks. More likely, it is movement of poultry, especially through markets, that initiates and fuels an outbreak. Salvage sales increase the dissemination of virus once the disease is recognised. All village chickens are sold as live birds, for consumption or for breeding. It does not seem feasible to control this aspect of the epidemiology of the disease. Suitable vaccines seem to be the only answer to the control of ND in village chickens.

IN MANY countries, ND is an important infectious disease. Control is possible, but this requires efficient applications of vaccines, and rigorous biosecurity. The epidemiology of ND is fairly well understood in commercial chickens. Factors that influence spread between flocks can be addressed with physical and chemical barriers. Vaccination hinders spread within a flock. Aspects of the epidemiology of ND in commercial chickens have been reviewed by Alexander (1988) and Arzey (undated). Some of their observations are applicable to ND in village chickens.

### **Hosts**

ND as a clinical entity is most important in domestic chickens. However, most avian species appear to be

susceptible to infection, although few develop clinical signs. Turkeys and pigeons may also develop generalised disease, but clinical signs are rarely reported in geese and ducks.

ND has been isolated from a number of mammalian species. Replication of ND virus (NDV) in these hosts is probably not epidemiologically important for avian disease. Some strains will produce conjunctivitis in human patients (for example, laboratory workers and abattoir staff) and there are very occasional reports of an association with more serious human ailments.

### **Methods of Infection**

Chickens are susceptible to infection by both inhalation and ingestion of NDV. It is generally supposed that chickens are more susceptible to virus reaching the respiratory tract, but this may not be the case for all strains of NDV. Strains vary in tropism for organs and some strains seem adapted to faecal-oral spread. Once ND enters a group of susceptible commercial

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chickens, the resulting explosive outbreak is easy to understand. Spread will probably be by aerosol within the crowded community, and airborne virus may travel long distances.

The difficulty is in explaining the first event in an outbreak—the infection of the first bird in an isolated flock. With most commercial flocks, the entrance of an infected chicken should not occur. Aerosol transmission is a possibility if there is a large concentration of infected chickens in the area. Estimates of airborne spread extend to 40 km. It is expected that, as with foot-and-mouth disease, a large group of animals that samples a large volume of air will be more susceptible to aerosol spread than a small group. Otherwise, the virus is probably carried in mechanically. Many factors may be involved—contaminated human shoes and clothing, vehicles, crates, egg cartons, eggs and contaminated food and food containers.

Village poultry are a different epidemiological problem. The flocks are small, scattered and multi-aged. During the day while chickens are scavenging, the entire village population could be regarded as a unit. All the chickens are in direct or indirect contact. At night, the chickens will congregate in smaller household groups, either in houses, under houses or in trees. Huchzermeyer (1993) made interesting observations on the role of housing in the epidemiology of ND in villages. He believed that chickens that were housed at night were more susceptible. Infection then occurred by close contact and sick birds would infect healthy birds. If the birds roosted in trees, there was less spread. Sick birds could not reach branches to perch and remained segregated. He also noted that brooding hens and hens with clutches of chicks that were kept segregated could also escape infection. His contention was that infection occurred more readily at night, in the absence of solar radiation.

Distant aerosol is probably a rare method of entry of virus into a village flock, although it could well be an important method of spread within the flock. Intense sources of aerosol/virus are not available in rural areas, and the small village flocks sample small volumes of air.

Movement of infected chickens is probably the main source of virus. Village chickens are mobile and pass through markets. They congregate, spread virus and disperse. Even chickens purchased for consumption are purchased live and may mix for a while with the home flock. Many villagers are aware that outbreaks of ND may follow the introduction of a newly purchased or newly gifted chicken.

Many villagers are also aware of the infectious nature of ND and of the failure of any treatments. Dead birds are often consumed. Sick birds or

dangerous contacts are slaughtered for consumption, or sold. The sale of infected birds aids the spread of infection.

In many countries, outbreaks of ND occur at certain times of the year. There is a temptation to attribute the outbreaks to seasonal conditions. However, seasonal conditions may be only indirectly involved. Increased movement of chickens may be the direct influence. This has been suggested as the factor in Indonesia, where the planting of seedbeds requires the sale of household chickens to fund the purchase of seed rice. In Uganda, it has been suggested that outbreaks of ND during the dry season coincide with the travels of unemployed agricultural workers who carry chickens as gifts when they visit relatives. Outbreaks occur in other countries as flock numbers increase in anticipation of various festive markets.

### **Epizootic and Enzootic Newcastle Disease**

Epizootic ND is the form that comes most readily to notice. Susceptible flocks in whole villages or whole areas become infected within a short time. Mortalities are high and sometimes total. Chickens that survive will be resistant during subsequent outbreaks. Most flocks will have to be started again with chickens from outside the area. This is the form that is reported to official agencies and that attracts the attention of aid groups. This is the form that discourages villagers from giving their flocks adequate attention. The flocks are seen as uncertain and ephemeral, suited only to opportunistic harvesting.

We now recognise that an endemic form of ND occurs, with the virus being maintained in a partially immune population. The virus spreads slowly among the susceptible portion of the flock, and the occasional deaths are not stressful to the flock owners, nor sufficiently serious to attract official attention. Clinically healthy chickens that are incubating the disease cannot be detected as potential killers of other flocks. The author has been involved in several experiments where chickens purchased as healthy controls have introduced virus to the laboratory. Others have had similar misfortunes with purchased village chickens.

Endemic ND and indeed the dynamics of village flocks are more conveniently studied by computer models than in the field. Johnston and Cumming (1991) described such a model, based on data collected in the Philippines. In their study area, flocks were exposed to ND challenge for about 14% of flock months. The model indicated that virulent virus could remain endemic in an environment that held as few as 500 breeding chickens with movement between groups. In a breeding flock, there is a constant introduction of susceptible newly hatched chicks.

### **Relevance to Control**

In commercial poultry, an important aspect of the control of ND is the exclusion of the virus. This can include strict quarantine on a country basis and strict biosecurity on a farm basis. Biosecurity approaches will not protect village flocks from the predations of ND. There is no way to control the movements of people and of animals, nor of curtailing the marketing of live chickens. The most that can be expected is some element of biosecurity within the village. Extension messages should include the segregation of unhealthy birds and the proper disposal of dead birds, viscera and feathers that remain if the birds are eaten.

The other arm of ND control in commercial chickens is vaccination. This is often effective for the flocks are large and uniform, and vaccines can be kept at suitable low temperatures until the point of delivery. The vaccines are sophisticated and produced in large dose formats to achieve economies of scale. The use of these vaccines in village chickens is

limited by cost, dose format and thermostability. Suitable vaccines are only now becoming available for village chickens. These will be relatively simple vaccines, locally made but derived from thermostable stock to reduce the reliance on refrigeration. New vaccination technologies and appropriate extension methods will have to be developed for each country.

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# A Comparison of the Different Vaccines Available for the Control of Newcastle Disease in Village Chickens

J.G. Bell<sup>1</sup>

## *Abstract*

This paper briefly reviews the advantages and limitations of the different vaccines available for use against Newcastle disease in village chickens. Inactivated vaccines give very good immunity without vaccinal reactions and have been widely used, but are relatively expensive and require training to apply. Live vaccines are easy to apply and relatively inexpensive, and give moderately good immunity. Vaccinal reactions to them vary according to the vaccine strain. Among the live vaccines, the heat resistant vaccines have the significant advantage for village use of easy transportation, and they have also been widely used in villages. Recombinant vaccines have the advantage that they can be serologically detected independently of the wild virus.

FIFTY years or more have passed since vaccine was first used to protect village poultry against Newcastle disease (ND) (Placidi and Santucci, 1952). During this time, a wide variety of types of vaccine has been developed. Many, but not all, have been tested on village poultry. It is the purpose of this paper to present a brief review of the different kinds of vaccine available. It is not the intention to recommend a particular vaccine, but rather to try to outline the relative advantages and limitations of each kind with particular reference to its use in the village situation. Examples will be given of the use of the different vaccines, but this does not pretend to be a comprehensive review of all the work in the field.

The principle of vaccination against a viral disease is well known: to elicit an immunological response against the virus in such a way as not to cause the disease itself. The simplest way to do this is to take the virus, kill it, and then inject into the bird. This is an inactivated vaccine. Another approach is to select a naturally occurring virus that is not virulent enough to cause serious disease, and infect the birds with this virus. This is a live vaccine. This approach can be taken further by taking a non-virulent natural virus and selecting a clone from the virus population with desirable properties, such as lack of vaccinal reactions, or heat resistance. This is a cloned live

vaccine. Finally, it is possible to specially genetically engineer a vaccine by, for example, taking part of the genetic material of the virus that codes for a surface antigen, and inserting this in another, different, virus to produce a recombinant vaccine.

We will now look in more detail at how these different approaches to vaccination have been applied to ND.

## **Inactivated Vaccines**

Inactivated vaccines are produced by growing a virulent virus in eggs, and then treating it with an inactivating agent, such as beta propiolactone. An adjuvant, such as an oil, is then usually added to make the virus more immunogenic. After inactivation, the vaccine is no longer capable of replication or spread. This means that it has to be individually injected into every bird to be vaccinated. It is normally injected into the back of the thigh muscle, using 0.3 or 0.5 mL per bird. This requires some training, and cannot be done by every keeper of chickens without prior demonstration. Inactivated vaccine produces very high levels of antibodies against ND virus (NDV), and provides a good level of protection against the virulent virus. In intensive poultry production, it is applied after an initial priming vaccination with a live vaccine. In village poultry, we have found that it gives good results in

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the absence of an initial vaccination with live vaccine (Bell et al. 1990). The reason for this is probably that, as serological surveys have shown where they have been carried out (Bell and Mouloudi 1988), some antibodies to the virus are already present in the village poultry as a result of previous infection by the wild virus.

Inactivated vaccines have already been used extensively in village poultry. One of the best examples is in Bangladesh, where 'village vaccinators' have been trained to go around villages in their area vaccinating the family poultry, achieving a high degree of coverage. Burkino Faso is another example of a country where inactivated vaccine has been used in a successful project (Verger 1986).

Although inactivated vaccine gives good protection, it is relatively expensive to produce. It also carries a slight risk to the user of accidental self-injection. While it is heat sensitive, it is much less so than conventional live vaccines making its transport to villages more feasible. It is produced by all commercial vaccine companies, and some regional and national government facilities.

### Live Vaccines

Live vaccines differ from inactivated vaccines in that they can replicate in the host. This is both an advantage and a disadvantage. It is an advantage in that it is not necessary to vaccinate every bird individually; the vaccinal virus can spread on its own from one to another. It is, however, a disadvantage in that since an infection with a live virus is involved, the birds can react to the vaccination in manifesting some of the signs of the disease. The severity of this reaction depends on the particular vaccinal strain used (Westbury et al. 1984) and the presence or otherwise of concurrent infection with other pathogens.

Another advantage of live vaccines compared to inactivated vaccines is their ease of application. They can be applied in drinking water or by putting a drop of the virus suspension from a dropper bottle into the eye of the bird while holding the head so that the eye is horizontal. Although drinking water application is the method widely used in intensive poultry farms, the eye drop method is probably the method best adapted to village poultry, since the drinking water supply is often irregular, and it is difficult to ensure that the vaccine is consumed while the virus is still active.

Although NDV has essentially only one serotype, there is a wide difference in the pathogenicity of different strains, ranging from strains which cause virtually no detectable signs to those that kill within a few days. These have been classified, in order of increasing pathogenicity, into lentogenic, mesogenic

and velogenic strains. These categories do not represent distinct groups, but rather divisions within a continuum of pathogenicity. The majority of live vaccines are derived from lentogenic strains, although there are, perhaps surprisingly, some vaccines derived from mesogenic strains.

We will now consider in more detail the different kinds of live vaccine.

### Conventional lentogenic vaccines

Some well-known examples of this kind of vaccine are Hitchner B1 (HB1) and La Sota. HB1 has very mild vaccinal reactions and is widely recommended for the initial vaccination of intensively farmed poultry. In a controlled trial in village poultry it provided effective protection against ND (Bell et al. 1990). La Sota produces moderate vaccinal reactions, and is thus in theory unsuitable for vaccinating a multi-age population including young chicks such as is inevitably seen in the village situation. This is because the virus spreads and it is not practical to isolate the adults from the chicks. I say 'in theory' because it does in practice depend on the residual level of antibodies from prior infections with virulent virus, which could protect the birds from vaccinal reactions, and to the extent of other concurrent infections, such as mycoplasmas, pathogenic *E. coli*, or infectious bursal disease virus, which can exacerbate the vaccinal reactions.

These lentogenic vaccines have been cloned by taking a single infectious virus and growing a homogenous population from it with the aim of selecting a virus which gives less vaccinal reactions than one like La Sota, while retaining its superior immunogenicity compared to one like HB1. An example of this kind of vaccine is 'clone 30'.

All these conventional live vaccines suffer from the disadvantage of requiring to be kept at low temperatures to maintain their efficacy. This is not a problem for intensive poultry production in an industrial setting, but the maintenance of the 'cold chain' during distribution can be very difficult in village settings, particularly in settings of high ambient temperature.

Another problem that is often encountered when using these vaccines in the village situation is that they are sold in vials containing 1000 or 500 doses, many more than the average village farmer needs. In fact, the packaging is a major component of the cost of manufacturing them, so that a vial containing a smaller number of doses would not reduce the cost proportionally.

Oil adjuvant, normally used with inactivated vaccines to improve immunogenicity, has also been tested with live vaccines and found to improve

immunogenicity (Peleg et al. 1993), but this combination has not been tested in village chickens.

### **Heat resistant vaccines**

Lentogenic viruses have also been cloned by selecting heat resistant clones to produce heat resistant vaccines. These have the distinct advantage in the village situation that it is possible to transport the vaccine without necessarily having refrigerators along the way. The most extensively used has been the NDV4-HR vaccine. This was pioneered in Malaysia, where eventually a significant proportion of the village poultry was covered by this vaccine (Ibrahim et al. 1992). The route of application was on feed, which it was possible to pre-coat with the vaccine, given its thermostability. This has the advantage that it is not necessary to catch the chickens before vaccinating them. The same vaccine has also been extensively tried in other countries in Southeast Asia. Tests of its application on a variety of feedstuffs have produced variable results. (Spradbrow 1992). It has been tested in some African countries, applied by eye drop, and has given good protection against the virulent virus (Saglid and Spalatin 1982; Bell et al. 1995). Given the difference between African and Asian feeds, the variety of feeds within Africa, and the variable results with some feedstuffs in Asia, it does seem as though application of this type of vaccine is best done by eye drop. It can be argued that the additional security provided by the vaccine is an incentive to invest in some form of housing, in which case catching the chickens is no longer a problem. More recently a similar vaccine to NDV4-HR, called I-2, has been made available for local production in developing countries, which adds the significant advantage of low cost. In a trial in Vietnam where village chickens were vaccinated with I-2, chickens were protected against artificial challenge (Tu et al. 1998).

### **Mesogenic vaccines**

Mesogenic strains have long been used for vaccination in the village situation. These would produce severe vaccinal reactions in a naive population, and the only reason that they can be used without having a severe pathogenic effect is that the velogenic virus circulates sufficiently frequently to ensure that there are always some residual antibodies. The use of this kind of vaccine would not be advisable anywhere where chickens could be found without any immune protection against the virus, on account of the vaccinal reactions. Normally they are used after a first vaccination with a lentogenic vaccine. The Komarov vaccine is an example.

### **Recombinant Vaccines**

NDV has two surface glycoproteins, called F for fusion, and HN for haemagglutinin neuraminidase. The genes coding for either of these can be inserted into a different kind of virus to make a recombinant vaccine. For example, the fusion gene inserted in herpes virus of turkeys produced a vaccine that gave good protection against virulent NDV (Morgan et al. 1993). One advantage of this technique is that the host virus can have a better stability than NDV. Another advantage is that antigens for multiple different pathogens can be inserted into the same host virus to produce a single vaccine against several different diseases. Perhaps its most significant advantage for use in the field is that it is possible to monitor the response to the vaccine independently of the wild virus but in its presence, and conversely it is possible to detect antibodies against the wild virus in the presence of vaccination. This is done by using an enzyme linked immunoabsorbent assay (ELISA) that uses a purified antigen, and comparing the results with those of an ELISA using a whole virus antigen. For example, Makkay et al. (1999) prepared an ELISA using only nucleocapsid protein of NDV as antigen. This detected antibodies against wild virus, but not antibodies against a recombinant fowlpox virus expressing HN glycoprotein. A parallel ELISA using whole virus as antigen detected antibodies against the vaccine.

However, this type of vaccine has not yet, to the author's knowledge, been tested in village poultry. A disadvantage of recombinant vaccines is that where they have been developed commercially the cost will be high.

### **Discussion**

The most immunogenic of the vaccines is the inactivated vaccine, given the residual antibodies that exist anyway in the village chicken population, that in effect take the place of the priming vaccination that is done in naive intensive flocks. The next most immunogenic are the live mesogenic vaccines, at the expense of possible vaccinal reactions.

The inactivated vaccine also has the advantage of not inducing vaccinal reactions, which it shares with the recombinant vaccine. The heat-resistant clones in practice produce almost no vaccinal reactions, whereas the other live vaccines produce slight to moderate reactions, depending on the vaccine strain and the immune status of the population vaccinated.

The inactivated vaccine is however the most difficult to apply: some sort of training is necessary before the injection required is mastered. All the live vaccines and the recombinant vaccines are, by

comparison, easy to apply. Feed application, which has been used for the heat-resistant vaccines, is even easier than eye drop vaccination. However, as discussed above, the variable results obtained and the variation in feed in different places argue against this route of application.

For transportability, the heat-resistant vaccine is best. It can be transported to even remote villages under high ambient temperatures without a chain of refrigerators. The inactivated vaccine is next best, having a better heat tolerance than the live conventional vaccines.

In choosing a vaccine for use in the village situation, one factor to take into consideration is previous experience with that type of vaccine. There has been extensive village experience in the use of both heat-resistant and inactivated vaccines. Live mesogenic vaccines have also been used in villages, particularly in Asia. The other live vaccines, with the possible exception of some clones, have at least been formally tested in villages.

The recombinant vaccines are the only ones that can be monitored serologically independently of wild virus.

Finally, cost is an important factor to consider. All the live vaccines are relatively cheap, and can be even cheaper if they are produced locally. Inactivated vaccine is more expensive, and the recombinant vaccine is likely to be very expensive when produced commercially.

These advantages and limitations of the different types of vaccine are summarised in Table 1. The assessments given are only estimates, and are not meant to be definitive. By 'spreadability' I mean the capacity of the vaccine to immunise individuals other than those that were individually vaccinated. By 'seromonitorability' I mean the capacity for antibodies to the vaccine to be detected independently of antibodies to the wild virus.

The choice of which vaccine to use is going to depend not only on the preceding factors, but also on the conditions pertaining to a particular region, such as the structure of veterinary services, previous experience, the population distribution, the communication infrastructure and the climate.

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**Table 1.** A summary of the advantages and limitations of the different vaccine types.

	Vaccine type					
	Inactivated	Live				Recombinant
		Lentogenic		Mesogenic		
		Conventional	Cloned			
	Conventional	Heat resistant				
Example	Newcavac	La Sota	Clone 30	I-2	Komarov	HVT/F
Immunogenicity	Very good	Moderate	Moderate	Moderate	Good	Moderate
Vaccinal reaction	None	Moderate	Slight	V. slight	Severe	None
Ease of application	Difficult	Easy	Easy	Easy	Easy	Easy
Transportability	Good	Poor	Poor	V. good	Poor	Moderate
Previous village use	Extensive	Some	No	Extensive	Yes	No
Spreadability	No	Yes	Yes	Yes	Yes	Yes
Seromonitorability	No	No	No	No	No	Yes
Cost	Moderate	Low	Low	Low	Low	High

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# Thermostable Newcastle Disease Vaccines

P.B. Spradbrow<sup>1</sup>

## *Abstract*

Robust vaccines are required to protect village chickens against Newcastle disease. Thermostable vaccines derived from avirulent Australian strains of Newcastle disease virus (strains V4 and I-2) have proved successful for this purpose. These vaccines have been developed through ACIAR projects and have been adopted by other international aid agencies. It is now possible to offer integrated workshops in which administrators and field workers are trained in the use of thermostable vaccines, poultry-specific extension activities and gender aspects of poultry production. At the same time, laboratory workers are taught the skills required to produce and test thermostable vaccine on a small scale, and to assure the quality of the product. Vaccine seed material is supplied without cost. Recent events in Australia have led to some concern among potential users of the vaccine. Virulent strains of Newcastle disease virus have apparently risen from the avirulent strains that have been circulating in Australia for at least 30 years. Some have suggested that the virulent strains of Newcastle disease virus first recognised in 1926 were derived by a series of mutations from pre-existing avirulent viruses. The virulence of strains of Newcastle disease virus is currently judged by the sequence of amino acids at the cleavage site of the viral fusion (F) protein. Work in several laboratories has indicated that the sequences in V4 and I-2 are similar to those in other mild vaccine strains. One mesogenic vaccine strain used in developing countries has the same sequences as velogenic viruses. It is also argued that the Australian 'virulent' viruses do not produce a disease with high mortality and would be insignificant pathogens compared with Newcastle disease viruses that circulate in Africa and Asia. Thermostable Newcastle disease vaccines, locally produced and widely distributed, would allow village chickens to contribute fully to alleviating poverty and improving nutrition in rural areas. Suitable systems of extension and cost recovery would make the enterprise sustainable.

MOST people attending this meeting would agree that village chickens are a very important resource for populations in rural and peri-urban areas in developing countries. Most would agree that village flocks are not managed to produce at their full potential. In most cases, the major constraint to enhanced productivity is the viral disease known as Newcastle disease, which devastates poultry populations in developing countries. Commercial vaccines and attention to biosecurity are important steps in the control of Newcastle disease in commercial chickens. Only over the past 10 or 15 years have we been able to contemplate the control of Newcastle disease in village chickens. The key has been the production of vaccines that are cheaper, less complex

and more robust than commercial Newcastle disease vaccines.

The problems have been many. The flocks are small, scattered and multi-aged. The owners of the chickens (often women) lack economic or political influence, and veterinary and extension services are seldom responsive to their needs. Commercial vaccines are not suitable for use in resource-poor villages. Individual vials contain at least 1000 doses (economies of scale), the vaccines are heat-labile and require continuous refrigerated storage and if imported they are a drain on foreign exchange.

The author believes that these problems can be overcome, and bases this assertion on his experience with control of Newcastle disease since 1984. In many places, it is not yet feasible to construct cold chains to link vaccine producers to village flocks, so thermostable vaccines are required. Not all the chickens can be caught readily for vaccination, so

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the vaccines must be able to spread between chickens, and to be given on food if necessary. Local production of vaccine will reduce the demand on foreign exchange. Vaccination packages are required that include vaccine production, training at all levels and effective and specific extension programs.

The present paper will address the virological aspects of these vaccination packages. It will trace the development of thermostable vaccines and indicate the several countries where these vaccines have been successfully tested and the few where they are in general use. The difficult transition from successful trial to implementation needs to be explored. The paper will also touch on two safety issues that have recently arisen. One concerns the recent occurrence of clinical Newcastle disease in Australia, probably the result of evolution of Australian viruses. The other is the view of the author that village vaccines need not be made in specific-pathogen-free eggs.

### **Newcastle Disease Viruses in Australia**

Newcastle disease was first recognised and the disease named in 1926. Some have argued for an earlier origin. However, the virus spread very widely and reached Australia in the early 1930s. Classical veterinary control measures, with diagnosis, slaughter and movement control, sufficed to eradicate the disease. The causal virus was isolated and maintained. It is still available within laboratories.

There were no further occurrences of clinical Newcastle disease and it caused some surprise when Newcastle disease virus was isolated from a healthy domestic chicken in Queensland in 1966 (Simmons 1967). The virus, designated V4, proved to be unusual. It was not pathogenic for chickens and failed to kill chick embryos. It was soon shown that avirulent viruses of this type were widespread in Australia.

V4 virus was relatively thermostable and it was demonstrated in the author's laboratory and in Malaysia that it would respond rapidly to selection for enhanced thermostability. V4 was soon being used as a vaccine, in its native form in commercial chickens and in its heat-resistant form in village chickens. The heat-resistant variant is now the basis of vaccines for commercial chickens. Early stocks of the V4 vaccine were held for possible emergency use in Australia and they were sold commercially in Asia and Africa. The heat-resistant V4 (NDV4-HR) has been used in recent control operations in Australia.

The author had warned the commercial poultry industry in Australia that an incremental increase in virulence of endemic strains of Newcastle disease virus was probably a greater risk than the entry of virulent exotic strains. An examination of 45

contemporary isolates of Australian viruses failed to demonstrate any pathogenicity for chickens. One of the viruses in this collection was the strain designated I-2 (Spradbrow et al. 1995).

In 1999, there were reports of the association of Australian strains of Newcastle disease virus with late respiratory disease in broiler chickens. Shortly after there were outbreaks of clinical Newcastle disease which triggered initially a test and slaughter response and later a salvage and vaccinate response. Viruses with biochemical markers for virulence (see later) were isolated. Details of these outbreaks have yet to appear in the scientific literature. It is difficult to establish what the Newcastle disease specific mortality was, or how the virus affects laboratory chickens when it spreads by contact.

Reports to *Office International des Epizooties* (OIE), placed on the Internet by ProMED, are available. They indicate that, at least for some outbreaks, morbidity was extremely low and there was no mortality. However, by the new OIE standards, the virus was virulent.

### **Thermostable Newcastle Disease Vaccines in Developing Countries**

Almost since its foundation in 1984, ACIAR has had an interest in village chickens. Dr John Copland became convinced in the early 1980s that the control of Newcastle disease was an essential start to the improvement of productivity in village chickens. He brought together the author's group from the University of Queensland and Professor Latif Ibrahim's group at the Universiti Pertanian Malaysia to consider the problem. It was decided that a possible approach would be to develop a thermostable vaccine from the Australian V4 strain and to exploit its ability to spread between chickens. Because village chickens were seldom housed in Malaysia at that time, it was decided to produce a vaccine that could be given on food if necessary.

The author has reviewed the ensuing literature on thermostable Newcastle disease vaccines, which is now extensive (Spradbrow 1993-94). An update of this literature was placed on the website of the FAO electronic conference *The Scope and Effect of Family Poultry Research and Development* (Spradbrow 1999). The permanent site of this information is <http://www.fao.org/waicent/faoinfo/agricult/aga/agap/lps/fampo/fampo.htm>.

Only a summary need be given here. The thermostable vaccines, either NDV4-HR or I-2 have been tested successfully in many countries in Asia and Africa. Eye drop vaccination is most effective but some suitable food carriers have been identified. These can be used where it is impossible to catch

chickens, or where there is a strong local preference for food vaccination for other reasons. A few countries have proceeded to local production and distribution of thermostable vaccines. Others would like to follow this path and seek guidance.

Laboratory protection trials with thermostable vaccine have been almost universally successful. Countries commencing to produce vaccine can probably dispense with these. Thermostable vaccines, if properly applied, are protective. The procedure that will require experimentation is the field delivery of vaccine. The response to vaccination can be judged adequately by the serological response of the vaccinated chickens. There is no call for further challenge trials. Countries wishing to use food vaccine will have to validate suitable food carriers.

Many of the research requirements have been completed. Those that remain are very practical—how to optimise vaccine yields, how to determine potency rapidly, what are suitable quality assurance standards, what are the best diluents for maintaining thermostability? Future assistance packages will have large training components and small research components.

The initial ACIAR training workshop established a format that, with modifications, has been successful in other countries and for other agencies. One workshop is held for administrators and extension workers. This covers Newcastle disease, Newcastle disease vaccines, village chickens, extension methods, gender aspects of poultry production and ethnoveterinary medicine. A parallel workshop for laboratory workers teaches the skills needed to grow Newcastle disease vaccine in embryonated eggs, to harvest vaccine, to titrate Newcastle disease virus and to measure antibodies to Newcastle disease virus. Fortunately, the egg work and the serology are relatively simple so these activities can be undertaken in many laboratories in developing countries. To date workshops have been held in Pretoria (for ACIAR), Dar es Salaam (for ACIAR), Accra (for GRM International and World Bank), Yangon (for FAO), Phnom Penh (for FAO) and Thimphu (for AusAID). An extended workshop is being conducted in Brisbane in 2000 as part of a fellowship scheme for IAEA. Workshop manuals were prepared and have been revised for subsequent workshops (Alders and Spradbrow 1999; Spradbrow et al. 1998).

As part of the laboratory course, master seed material of I-2 vaccine is made available without cost. At some workshops, working seed and even vaccine is then produced. The intention is that laboratories will be able to make thermostable vaccine in some form in embryonated eggs. Often these will be commercial hatching eggs, already in use for making other vaccines. Some laboratories in developing countries have facilities for freeze-drying

vaccines. Others will produce 'wet' (that is liquid) vaccines, which will need to be distributed within a few weeks.

Distribution networks for vaccine will need to be established. These are discussed elsewhere in this volume. Extension activities that specifically target village poultry will be required. Vaccinators will need to be trained at farm or at village level. For vaccination projects to be sustainable, systems of cost recovery must be developed.

### **Avirulence, Virulence, Reversion to Virulence**

All strains of Newcastle disease are serologically similar when examined with polyvalent antiserum. The use of monoclonal antibodies does allow fine distinctions to be made. However, strains of Newcastle disease virus vary enormously in virulence, which is a measure of the degree of pathogenicity. Virulent strains of Newcastle disease virus will kill most of the chickens that they encounter. Strains of low virulence may produce disease in some chickens but no deaths.

Three useful terms were introduced to indicate the virulence of Newcastle disease viruses.

VELOGENIC viruses were highly virulent and might have tropism for respiratory and nervous tissues — NEUROTROPIC VELOGENIC — or for visceral organs — VISCEROTROPIC VELOGENIC.

MESOGENIC viruses were moderately virulent.

LENTOGENIC viruses were of low virulence.

Some added a fourth category, AVIRULENT, to cover virus strains like V4 and Ulster which do very little damage.

OIE unfortunately has ceased to recognise these terms.

The writer believes that the virulence of strains of Newcastle disease virus should always refer to their effect on chickens. The commonsense approach is that virulent viruses cause clinical disease and mortality. Alexander (1996) has pointed out the complications that arise when mild strains or even vaccine strains of Newcastle disease virus are isolated from clinical disease that is exacerbated by co-infecting microorganisms or environmental factors. Laboratory tests were required that might indicate the potential virulence of a strain of virus.

Three tests came into accepted use. The mean death time is measured in embryonated eggs from a specific-pathogen-free source inoculated by the allantoic cavity route with a minimal lethal dose of virus. Velogenic viruses killed in under 60 hours and mesogenics in 60 to 90 hours. Avirulent viruses fail to kill. Another test measures the reaction of one-day-old specific-pathogen-free chicks to intracerebral

injection of virus. The result is converted to an index (ICPI or intracerebral pathogenicity index) that varies from zero to a maximum of 2.0 for velogenic viruses. A similar index (IVPI or intravenous pathogenicity index) with the values 0 to 3.0 is calculated after intravenous inoculation of specific-pathogen-free chickens at 6 weeks of age.

Recently, some of the molecular determinants of virulence in Newcastle disease virus have been determined. Most attention has been devoted to one of the surface proteins of the virus particle, a protein known as the fusion (F) protein that is concerned with the entry of virus into cells. Viral genes code for an inactive form of this protein, referred to as F<sub>0</sub>. The virus particle will not be infective until this inactive protein is cleaved into two portions F<sub>1</sub> and F<sub>2</sub> that combined have fusing ability. Cleavage is achieved by host nucleases that act on a specific cleavage site. For some strains of Newcastle disease virus, a particular protease is required. Infectious virus is produced only when suitable cells are infected. In the chicken, these viruses are restricted to the cells of the enteric and respiratory tracts and little or no disease results. In embryos inoculated in the laboratory, the virus is restricted to the layer of cells lining the allantoic cavity. The embryo itself is not infected and survives. Other strains of Newcastle disease virus have an F<sub>0</sub> that is readily cleaved by many proteases. These viruses can colonise a wide variety of cells and spread throughout the host, killing chickens and embryos.

Thus, the chemistry of the fusion site of the F<sub>0</sub> protein is probably important in determining virulence of Newcastle disease viruses. The sequencing of viral genes is now a relatively simple procedure, and from the nucleotide sequence of the gene, the amino acid sequence of the protein that is that gene's product can be deduced.

Biochemists use a simple alphabetical code to indicate a particular amino acid. Those of relevance now are:

**R** arginine;

**K** lysine.

These are in heavy type because they seem to be part of a virulence motif when they occur against the cleavage site at the end of the F<sub>2</sub> portion of the F<sub>0</sub> protein. They are two of the three basic amino acids:

**Q** glutamine;

**G** glycine;

**E** glutamic acid;

**L** leucine.

These are written here in normal type, as they seem to have no effect on virulence.

**F** phenylalanine.

This is also written here in heavy type. It is a virulence indicator when it occurs immediately after

the cleavage site, as the first amino acid of the F<sub>1</sub> protein. It is not a basic amino acid. Avirulent viruses have leucine at this site.

Collins et al. (1993) studied this area of protein in 26 Newcastle disease viruses. There is now substantial unpublished work on many recent Australian isolates.

The fusion site is at an R (arginine) residue at the 116<sup>th</sup> amino acid on the F<sub>0</sub> protein. This is present in all strains of the virus.

Most virulent viruses have the following sequence:

112 **R** or **K-R-Q-K** or **R-R** 116 117 **F**

There are four basic amino acids at residues 112, 113, 115 and 116, and phenylalanine at 117 after the cleavage site.

Avirulent viruses are different. Collins et al. (1993) gave this general scheme

112 **G** or **E-K** or **R-Q-G** or **E-R** 116 117 **L**

There is evidence from Ireland (Collins et al. 1993) for the mutation of an avirulent virus to a virulent pathotype. This involved the replacement of amino acids at 3 residues (112, 115 and 117). The authors commented that this '... would not be a simple process or frequent occurrence ...'. Studies with monoclonal antibodies indicated that the virulent and avirulent viruses were similar and probably a common gene pool.

The Australian V4 strain has the low virulence sequence

112 **G-K-Q-G-R** 116 117 **L**

Strain I-2 (D.J. Alexander, pers. comm.) and strain Ulster share this configuration.

The strain known as Blacktown and associated with disease in the recent Australian outbreaks sequenced as follows, as reported by Anon (1999) in a newsletter distributed to industry.

112 **R-R-Q-R-R** 116 117 **F**

Collins et al. (1993) included some vaccine strains of Newcastle disease in their study.

The vaccine strains B1, La Sota and F had identical sequences

112 **G-R-Q-G-R** 116 117 **L**

Komarov, a vaccine still used in some countries, has the structure of a virulent virus

112 **R-R-Q-K-R** 116 117 **F**

Table 1 gives an indication of the lessons that have been drawn from these studies.

Obviously, there are factors other than the arrangement of six amino acids at a particular site that influence the virulence of strains of Newcastle disease virus. However, the technology to make these determinations has become routine but the official decision to rely on amino acid sequences may be too simplistic. An OIE Committee resolved and OIE adopted in 1999 an amended standard. Newcastle

disease was defined as an *infection* by a virus that had either

‘an intracerebral pathogenicity index of 0.7 or greater, or at least 3 basic amino acids in the position of residues 113 to 116 and phenylalanine at 117.’

**Table 1.** Amino acid sequences at the F protein cleavage site.

Residue number	Pathotype	
	High virulence	Low virulence
112	<b>R</b> or <b>K</b> (basic)	G or E (not basic)
113	<b>R</b> or <b>K</b> (basic)	<b>R</b> or <b>K</b> (basic)
114	Q (not basic)	Q (not basic)
115	<b>R</b> or <b>K</b> (basic)	G or E (not basic)
116	R (basic)	R (basic)
Cleavage site 117	F	L

There is no mention in the definition of clinical disease or death in chickens. Australian authorities also look for a basic amino acid at residue 112.

The definition assumes that all viruses of this configuration will be pathogenic. Veterinary laboratories in developing countries wishing to comply with these requirements would require a molecular biology laboratory or access to one-day-old chicks from specific-pathogen-free stock. This test also has limitations, apart from those of animal welfare. It has long been recognised (Mims 1960) that intracerebral inoculation is a crude way of introducing an inoculum to the blood stream. Only that part of the inoculum along the needle track is likely to remain in the brain. Kim and Spradbrow (1978) found moderate intracerebral pathogenicity indices (0.9 and 1.0) for strain V4, but the viral lesions were in liver and spleen, and not in the brain.

Perhaps the ability of Newcastle disease viruses to cause disease and death in the field should also be part of a consideration of virulence. Viruses with ribonucleic acid (RNA) genomes will readily produce mutants. Vaccines produced from seed lots to minimise the chance of genetic change. The strains of Newcastle disease virus that circulate in the field are not clonal (Hanson 1988). Hanson (1988) noted that isolates of Newcastle disease virus contained variants that remained hidden until their presence was revealed by applying suitable selection pressures. When pathogenicity indices or sequences or

thermal stability are measured, it is the predominant population in the mix that is being measured. Suitable selection pressures are required to reveal the variants whose presence may be required for viral persistence. The author prefers not to clone viral seed lots, to preserve any heterogeneity that may be important for immunity. Selection pressures can be controlled in the vaccine production laboratory. Once in the chicken, the vaccine virus will be subjected to the selection pressures that also mould the wild type viruses. It is difficult to envisage that the progeny of any lentogenic Newcastle disease vaccine virus will do serious harm. They are extremely unlikely to match the pathogenicity of the virulent strains already in circulation.

### Specific-pathogen-free eggs

Modern egg-based vaccines are made from eggs derived from specific-pathogen-free (SPF) flocks. The breeding chickens are in isolated buildings, often supplied with filtered air. They are derived from parents free from a long list of pathogens (the specified pathogens), and frequent testing assures the microbiological integrity of the flock. These flocks are very expensive to maintain, and consequently SPF eggs are very expensive. The SPF birds receive no vaccines. If vaccines are made from SPF eggs, in premises that meet standards of Good Manufacturing Practice, the vaccines should also be SPF. The status of the products is compromised if they are produced in other premises.

SPF eggs were introduced to exclude from vaccines, or from progeny chickens, certain pathogens that are transmitted through the egg. Avian leukosis virus and mycoplasmas were the agents causing most concern. Infectious agents have been transmitted with SPF egg-based vaccines. Often these were agents such as reticuloendotheliosis virus or chicken anaemia virus that were newly emerging and that were not included in the list of specific pathogens. Vaccines used in commercial poultry in developed countries should be produced in SPF eggs.

Some argue that vaccines for use in village chickens should also be made in SPF eggs. The costs would be prohibitive in many countries, and the chickens would not receive vaccine. In many developing countries, any locally made avian vaccines for commercial poultry are already produced in conventional eggs. The author knows of no instances where this has been harmful. For village chickens, any risks are far outweighed by benefits. Strains of Newcastle disease virus that cause extremely high mortality circulate in their environment.

Few potential pathogens will kill a high percentage of chickens, and these can be excluded from

vaccines: virulent Newcastle disease will; *Salmonella pullorum* and some pasteurellas will; and some strains of avian influenza will. Bacterial contamination can be detected by cultural techniques. Virulent strains of Newcastle disease will kill embryos, which will not then be harvested for vaccine production. The vaccine is given usually to older chickens, and it is given on mucosal surfaces and not injected. The contaminated commercial vaccines that have caused problems have usually been injected vaccines, given to young chicks.

The risks of harming village flocks with locally produced vaccines must be balanced against the fatal outcomes of contact with circulating strains of Newcastle disease virus. If we refrain from vaccination because SPF eggs are not available, chickens will continue to die unnecessarily, and an important source of protein will be lost to villagers.

### Postscript

A long time ago in Cambridge, the author met an old man who remembered the vaccine calf being brought around English villages. The calf would have been infected with what we now call vaccinia virus, the vaccine that protected against human smallpox. Not an ideal source of vaccine, but better than bovine exudate that had been transported by other means, and safer than the transfer of lymph from a human vaccine reaction. It was the best technique available at the time. Village chickens require access to Newcastle disease vaccine now, and flock owners deserve this service. We should strive for the best remedy that can be implemented, now.

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# The Social Impact of Newcastle Disease Control

B. Bagnol<sup>1</sup>

## *Abstract*

Widespread social impact can be achieved with the use of thermostable, live Newcastle disease (ND) vaccine NDV4-HR and I-2, applied via eye drop. Based on the evaluation of five ND vaccination campaigns carried out in Mozambique over a period of just under two years, significant and immediate increases in the number of chickens raised by households were recorded and acknowledged by the poultry breeders. Chickens are the most popular and most widely available livestock species raised by the households and by different members of the households. Thus, increased numbers benefit all individuals, regardless of gender, age or class. However, the impact of ND vaccination is higher among the poorest and women because they rely on chickens to provide for their basic needs such as food, hygiene, clothing, medications and schooling. The increase in the number of chickens is translated immediately into an improved access to cash or goods through exchange, but it also represents the possibility of gaining access to a good meal of higher nutritional value, and improved food security.

MOZAMBIQUE is an agricultural country with 16 million inhabitants, 71.4 % of whom live in rural areas (Instituto Nacional de Estatística 1999). The majority of the rural population (52.1 %) is made up of women (Instituto Nacional de Estatística 1999). In 1996, after 15 years of war, Mozambique was considered by the World Bank to be the poorest country in the world, with an annual income of US\$80 per person and a life expectancy of 46 years. The child mortality is high and 16% of children suffer acute chronic malnutrition (Ministério da Saúde and Instituto Nacional de Estatística 1997). In spite of the Rehabilitation Program that improved the situation somewhat, two thirds of the population are still living in absolute poverty (Ministério do Plano e Finanças et al. 1998). For this reason poverty is one of the major issues facing the Mozambican government.

Before independence, the commercial sector around the towns was the focus for poultry activity. With nationalisation that occurred after Independence, the government focused on the cooperative sector where ND vaccination campaigns were carried out using imported La Sota ND vaccine. Village chicken-raising, both for food and ceremonial purposes, is traditional in rural areas and is generally the

responsibility of women (Dohmen and Fafine 1998). As in other African countries, ND is the most pathogenic of the annual epidemics in Mozambique and destroys up to 50 to 100% of chickens. There is a consensus that vaccination campaigns have a vital role to play in the improvement of household food security and family income (Harun and Massango 1996; Mavale 1995; Wethli 1995). Currently three types of vaccine are used in Mozambique: La Sota, ITA-NEW and I-2. The last vaccine is produced locally in Mozambique by the National Veterinary Research Institute (INIVE) in collaboration with the ACIAR Newcastle Disease Control Project.

The work presented in this paper is the result of an independent evaluation carried out in Mozambique for the Australian Centre for International Agricultural Research (ACIAR) Newcastle Disease (ND) Control Project during January 2000 (Bagnol 2000). This project, based at INIVE in Maputo, started the local production of thermostable, live ND vaccine I-2 in 1999. Mabalane and Massingir districts (Gaza province) were selected for evaluation as NDV4-HR and I-2 had been used there for over one year. VETAID (a British NGO with a livestock development project in Gaza Province) implemented and supervised the ND control activities in collaboration with the ACIAR ND project. The major aim of the evaluation was to identify the benefits and constraints related to ND vaccination programs in rural areas.

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### **Characteristics of the Districts**

Unlike the coastal strip of southern Mozambique, which offers reasonable conditions for agricultural production, both in terms of climate and soil fertility, the arid interior zone is less favourable for agriculture. This is why emigration of the men to South Africa in search of work is a frequent phenomenon. In the majority of the districts, as in Massingir and Mabalane, it is possible to cultivate only along the river edges and lagoons, where the land is relatively more fertile and water from the river can be used for irrigation. Here the main food crops are maize, sorghum and millet, and the cash crops are cotton and tobacco (Ministério da Saúde and Ministério do Plano e Finanças 1998). The distances of the farming areas from the cities are long and the roads are in a dreadful condition, making commercial activity difficult. In Mabalane, livestock production in the family and private sectors comprises cattle (16 197 total herd), goats (7484 total herd) and sheep (2668 total herd), according to data from the livestock register for 1999. The situation is similar in Massingir, although smaller total numbers are registered. Data related to poultry flocks are not available. In addition to farming and livestock, the main sources of income for the poor families are the sale of traditional beverages, charcoal and firewood.

Data on food security and nutrition in Gaza province indicate a high incidence of chronic malnutrition. The feeding of infants is essentially done by breastfeeding. Weaning food is generally introduced between 18 and 24 months, but earlier in the event of a new pregnancy arising. The main foodstuff for children is pap made of maize, sorghum or millet meal, with salt or sugar. The majority of women state a lack of money as the main reason for not using other foodstuffs such as green vegetables, fruits and foods rich in animal proteins (Ministério da Saúde and Ministério do Plano e Finanças, 1998). In addition to poverty, which determines food availability, chronic malnutrition can be related to inadequate food practices in term of quantity, quality and period of introduction (USAID et al. 1997).

### **Newcastle Disease Vaccination Campaigns**

Among other objectives, the VETAID project aimed to develop a proper poultry health control program that would contribute to increased production and reduced losses of chickens due to disease, particularly ND. The project proposed to organise vaccination campaigns in collaboration with the National Livestock Directorate (DINAP) and aimed to reach a total of 25 000 birds per province in the first year of the project and 50 000 in the second. In the field,

VETAID worked with men and women selected by their communities to work as community livestock workers (CLWs). They received specific training in the treatment and prevention of the main livestock diseases which are prevalent in the region, and were equipped with materials and drugs to meet the needs of livestock breeders (Pagani 1999). With the introduction of the ND vaccination campaigns, the CLWs were responsible for vaccinations at the community level.

The activity reports produced by VETAID (Pagani 1999), indicate that between 1998 and 1999, vaccination campaigns against ND took place in five districts in Gaza province, and two districts in Inhambane province. The vaccine chosen was NDV4-HR given by eye drop, due to its low cost, ease of use and conservation, safety and easy substitution by I-2 vaccine to be produced by INIVE. Since May 1998, a total of five campaigns have been organised (one every four months), each one distributing between 40 000 and 54 000 doses of vaccine. It was estimated that between 20 000 and 25 000 chickens were vaccinated in all the districts as a whole for each of the first four campaigns (Pagani 1999).

From the beginning, payment for vaccines was introduced. Pamphlets on the vaccination and the price were distributed through the promoters to the poultry farmers. Initially the price of the vaccine was 200 Meticals (MZM; US\$1.00 = 14 000 MZM) per chicken, which covered only the costs of the labour of the CLW. As of 1999, the poultry farmers also had to pay for the vaccine, which translated into an increase of 100 MZM per bird vaccinated (Pagani 1999). At the end of 1998, it was decided to emphasise intensive extension and training work. Audio cassettes about ND control (with songs and radio programs in Portuguese, the official language and various local languages) produced by the ACIAR Project and INIVE were duplicated and distributed to the CLWs.

In 1999, a new working strategy was adopted with the goal of broadening the base of village chicken breeders interested in vaccination against ND. Given that the vaccine was easy to use and could be used by poultry farmers themselves, new community vaccinators were selected to be responsible only for vaccination campaigns against ND. District Livestock Officers would come to organise meetings with the farmers of their district, informing them of the possibility of preventing ND through vaccination, the number of times vaccine should be given to each bird and its cost. If farmers showed interest, two or three were chosen to receive brief training on how to use the vaccine, when it should be given and where to get the vaccine. This training program was based



on the information contained in the existing extension material produced by ACIAR/INIVE and VETAID (Pagani 1999).

As a way to monitor the vaccination campaigns, each CLW was given an information record sheet. The number of chickens vaccinated, the number of vaccinations carried out per day and the use of vaccine contained in each 100 or 1000 dose vials were recorded. On average, each promoter could vaccinate around 300 chickens per day, and used 323 doses of a 1000 dose vials and 85 of a 100 dose vial. This result is explained by the small size of the poultry-raising units, their dispersion, and the reluctance of the producers to pay for the vaccine (Pagani 1999).

Analysis of the data from the first and second vaccination campaigns, contained in the VETAID activity report, shows a substantial increase in the number of chickens per unit (from 7 to approximately 20). In November 1998, around 80% of the units had fewer than 10 chickens and a maximum of 29, while in May 1999, 53% of the units had between 11 and 30, with a maximum of 93 (Pagani 1999). Another interesting observation, which, while not quantifiable, was promising, was the increased regularity of the arrival of chicken buyers from the city of Maputo to the districts of Massingir and Mabalane, reaching even the most out-of-the-way districts. The purchase price of the chickens was between 20 000 MZM and 30 000 MZM per unit, which was quite good considering the price charged in Maputo.

### Maximising the Odds

The largest problem in chicken-raising is ND, which can kill almost all the flock. In the past, the disease used to appear at two clearly defined times of the year. Now it appears at any time, but generally in the period between June and November.

The number of chickens per household varies from 2 to 60 chickens (data gathered from the vaccination files of the Mabalane promoters). Within the household, chickens belong to various persons, to the head of the household, to the women and to children of all ages. It is the most widespread and egalitarian stock breeding activity existing. This situation is a strategy aiming at dividing the risk of mortality or, in other words, of maximising the odds. Most of the farmers of both sexes consider that success in animal raising, whether of goats, cattle or chickens, depends 'on each person's luck'. This luck is considered to arise from individual spiritual forces, as well as from God. According to this concept, at birth each individual possesses a 'knack' or a 'touch' for raising a given species of animals. This 'luck' should be tried out,

for which reason chickens are also given to children. If after some attempts, the person demonstrates a lack of success, through high mortality or disappearance of birds due to predators (dogs, snakes, birds), s/he abandons the raising of chickens.

In a polygamous household, each wife will try her 'luck' with chickens, thus seeking to feed herself, her children and her husband. When the chickens assigned to a woman were bought with the husband's money, the wife, depending upon the power relationship of the couple, often possesses the right to sell them without seeking her husband's permission. Generally only after having sold or consumed them does the woman inform the husband. It is good manners for the husband to do the same. In rare cases, the wife is obliged to ask her husband for permission to kill or sell a chicken that was given to her. A husband whose wife is made to do that is considered excessively domineering. Thus, the chickens are generally under the control of the woman and she has some autonomy in their use. One woman stressed that: 'with the chickens that are mine, I don't need to get down on bended knee in order to use them'. She is referring to the act of kneeling down before the husband to request something, and one infers that even though she may kneel down to inform the husband about the use made of a chicken, the meaning attributed to this act is different: it's one thing to ask, another to inform.

In the case of chickens assigned to children, effective ownership of the animals remains with the adults who bought the first chicken. However, when the children are of school age, they exercise a certain autonomy over their chickens and may sell them to buy school supplies. Depending on the person that offered the chicken, the child will have greater or lesser authority over their raising.

Since it is essential in subsistence economies, the poorer households cannot exclude chicken-raising and it is a rare family that does not have chickens. However, a few households are in this situation. Some had chickens in the past and due to high mortality of the birds, were not interested in raising them any more. Others lost chickens because of disease and have not yet gone back to raising them. Alternatively, the households may be very poor and may not have the resources to acquire chickens. When a household loses its chickens, the neighbours or family members loan them a hen in order to help relaunch the chicken-raising effort, but some people may be very demoralised and not want to take on the commitment of borrowing a hen, for fear of it dying while in their possession, thus creating a debt.

### **Social, Economic and Dietary Functions of Chickens**

It is a woman's role to deal with everything related to reproductive activities and a large part of the activities of a social nature (preparation of feasts and ceremonies). For this reason, chickens are of great importance in the value system and in the resources, which are accessible to and controlled by women. Chickens play this fundamental role not only because they provide food, but also because of the possibility of being sold or exchanged for staple goods or other products, the responsibility and control over which are given to women. Women exchange chickens for food products (salt, sugar, and oil), cleaning products (soap), clothes and school supplies for the children or medicinal drugs for the different members of the household.

As the men generally have larger animals under their care and control (goats and cattle), they leave the women with authority to oversee the raising of chickens and to take decisions in that regard. It is in their view an activity of lesser social prestige and lesser commercial value. Consequently, chickens are fundamentally a women's issue. Not only are they cared for and used by women, but they are also exchanged or sold to acquire goods that are used essentially to carry out the gender roles assigned to women. In addition, since most of the men have control over larger animals, they have other ways of acquiring and reproducing their power and access to the means of production and consumption that flow from that fact. However, in other areas of the country where men's access to other resources is more limited, control by women over chickens may also be different (Alders 1996; Mata et al. 2000).

In the same way as cattle or goats, chickens constitute a small-scale financial reserve, a monetary fund available to women, a female form of a living bank. The sale of a chicken will meet a small-scale need such as the purchase of staple products, medication, or clothes, pens and notebooks for children going to school. A goat is sold to buy clothing or meet medium-scale needs, while cattle are the maximum currency of exchange, serving to solve very serious problems, such as *'lobolo'* (in the south of Mozambique *'lobolo'* is both the name given to marriage under traditional custom, as well as the term used for the presents that the groom offers to the bride's family members), or house construction. Cattle are essentially used to enter into prestige negotiations.

Although cattle and goats are also slaughtered for the worship of ancestors, chickens are most frequently sacrificed and consumed on such occasions. Generally, the diviners consulted about the way to

conduct such ceremonies give voice to an ancestor's spirit who requests a bird with a specific colour and sometimes with ruffled feathers. Birds with the most requested characteristics are generally sold or exchanged at a higher price. As with goats and cattle, chickens can be attributed to an ancestor's spirit and thus cannot be sold or consumed without the performance of adequate ritual. In addition to ceremonies for the ancestors, chickens are also frequently necessary in ceremonies performed by various churches.

Chickens, like other livestock, are raised to use as a saving in order to respond to emergencies and prime necessities, and not so much for family consumption. For this reason only a very few people consume chickens and eggs. To illustrate her difficulty with consuming chickens and eggs, a woman stresses: 'it is very hard to kill a chicken and eat it. We would like to sell the chickens. I don't have the habit of always eating a chicken. I would prefer to keep it.' The proverbs gathered suggest that the limitation on use of eggs applies more to the children and women than to adult men. 'If one gives an egg to a child, he or she will become a thief'. 'If you give an egg to a child they end up bald like the egg'. 'If a woman eats an egg, at the time of giving birth she will be like a chicken running from one place to the other without knowing where to give birth'. While the food taboos related to eggs are tending to disappear, the concept that they serve to ensure the reproduction of the chickens and that eating eggs constitutes a waste and a luxury is maintained. For this reason, from a young age children are taught not to get used to eating eggs. In general, people usually do not take all or most of a hen's eggs, believing that the hen will then be sad and angry and stop laying them. Following the same logic, one cannot kill all of a hen's offspring.

As a result of the ND vaccination campaigns, the increase in total number of chickens is translated immediately into an increase in their sale and to a lesser extent in their consumption. The need for access to cash is immediate, while the change in alimentary habits is slower, and for that reason, despite the increase in the poultry flock, it is still unusual for chicken to be eaten on a regular basis. Nutritional advice could be given as part of the vaccination campaigns to promote adoption of new food habits and improve the nutritional value of diet.

Chicken is the favourite food for receiving visitors and constitutes the basic foodstuff for making a 'curry' or 'stew' on a special day. A chicken may be cooked for a guest as a sign of respect, or offered to a visitor as a gift. In the villages close to the Limpopo River, fish and chicken constitute the main alternative protein sources to the daily meal based on maize meal and vegetables. The chickens are cooked

in a 'curry' with sauce to accompany the maize meal, the pieces being apportioned between all members of the household, including the children. The father generally eats the gizzard, the head and one thigh; the woman gets a thigh and the back; the children of an age to run after chickens, get the feet 'in order to run more quickly'. The gizzard is considered the place where impurities accumulated so only men are allowed to consume it as they are considered the strongest. The habit of giving the man this privilege is disappearing and in some households, anyone at all may eat it, including the women themselves. A woman drawing a parallel between colonialism and the men's privilege explained this change: 'colonialism is over now, all of us can eat'.

In conclusion, chickens are the smallest animal raised both for consumption on special days and to supply small-scale family necessities. In this sense, chickens constitute a food reserve that fulfils a fundamental social and religious function, and provide a minimal source of money for basic needs. Because various individuals of different age and sex within the household own chickens, they constitute the most democratic animals raised.

### **Impact of Newcastle Disease Control among Different Social Groups**

Although apparently relatively unstratified, the rural society of the districts of Mabalane and Massingir has groups with distinct social and economic characteristics. Differentiation may be carried out using factors like the composition of the household, the number of women, of adult men and of female and male children, manpower being an indicator of wealth and of access to means of production, animals and area under cultivation. The differentiation may also take into consideration access to a source of paid work within the country or in South Africa, or possessions like goats and cattle and ploughs to work the fields. The social standing resulting from a position as a leader of a political or religious-traditional nature, also determines access to power and to the resources that exist in the area. The most vulnerable and poorest group is generally made up of single-parent nuclear households, that is, widowers and widows, or men and women living alone or with children. Female heads of household are generally considered to be a less well off group economically, due to the fact that they are not able to count on manpower or incomes of males. If they also have no male children of an age to shepherd the cattle or the possibility of having a herder, they will not have access to cattle, limiting the possibility of working extensive areas of land for the growing of subsistence foodstuffs.

In the first instance, the CLWs seek to motivate the traditional and political leaders of the villages to vaccinate their chickens by adopting an extension methodology that favours contact with the leaders. The latter will then motivate and mobilise the other households and will serve as an example. For the promotion of the vaccine, the leaders run the meetings, together with the CLWs. The women are considered by the CLWs to be the most innovative. They are the ones who are willing to risk trying the solution that is proposed as a way of improving their chicken-raising. The women show their satisfaction with the vaccine and the associated increased production, consumption and sale of chickens. On the other hand, men tend to put forward problems related to the cost of the vaccine and mention chickens that died after being vaccinated.

Poorer social groupings have the least financial means and the least possibility of investing money in a vaccine. They are not in a position to be the first to spend their meagre possessions on a novelty until they are confident of its benefits. If following the first vaccination, the vaccinated chickens survive and develop well and the unvaccinated chickens die, the poorer households will be more inclined to take the risk. Otherwise, they will maintain their production on a random basis, relying on the 'luck' of the different members of the household.

Where households lack the cash to pay for the vaccine, the CLWs are proposing payment in the form of a chicken. However, this proposal is still poorly accepted by farmers and does not manage to resolve the situation in households that possess few chickens. It does not make sense to hand over a chicken worth between 20 000 MZM and 30 000 MZM to pay what is owed for the vaccination. This issue is still being discussed and ad hoc solutions should be found between the farmers and the CLWs.

### **Impact of Newcastle Disease Control on Households**

Although vaccination brings benefits to all individuals of the family, the members are affected in different ways.

The benefit for the woman may be evaluated in terms of facilitating access to a source of protein for the preparation of family meals. The greater availability of chickens helps her search for foodstuffs for the preparation of the daily meal.

For women who manage to sell their poultry, chickens constitute a fundamental resource. In situations where only the men have access to cash crops and waged work, the women depend on them to supply their personal needs. Chickens can be compared with husbands in the sense that they can provide

women with basic supplies. As one widow explained 'the chicken is my husband, it allowed me to buy these shoes, this piece of cloth, this handkerchief.' With the increased production of chickens, women become less dependent on their husband's money and manage to satisfy some basic needs. The access to money that the possession of chickens confers is constrained by the proximity of a railway line or road, or the existence of transport to town in order to sell the product, or to convey travelling merchants to buy the chickens. Women explained that they are not able to sell their chickens and that they are not in the habit of travelling to the district headquarters to sell them. Thought must be given to the marketing of village chickens in remote areas.

Women consider chickens as the first step in animal-rearing activities. For them, selling 4 or 5 chickens offers the possibility of getting access to a goat bought in their name, with their money, and thus the hope (as in the fable by Jean de La Fontaine, 'Pierette et le pot au lait') of owning cattle one day. One woman stated: 'I am struggling to raise more chickens in order to be able to have a goat for myself'. A female CLW stressed that she has now managed to buy two goats from her chicken-raising and that her objective is to have cattle soon. In the villages where she undertook the vaccination campaign, other women did the same. This prospect might allow women improved access to resources they were denied previously. This might also modify gender relations within households, permitting women greater cash contribution to the household income and increased financial availability under their control.

For school-age children, chicken-raising (whether their own or the parents') is a source of money allowing access to notebooks, pens and the fees needed each school year. Chickens are also exchanged for clothes.

It is the consensus view that an increase in the production of chickens benefits the whole family. One male CLW stressed: 'Even the husband benefits from his wife's chicken-raising, because if he gets sick she will sell the chicken in order to buy drugs for him'. Increased production of chickens also increases the availability of food for people who pay visits to the household, and the consequent prestige that the hosts (men and women) obtain.

### Conclusion

Chicken-raising is the most widespread stock breeding activity both in general and within the household. ND introduces a high risk factor into chicken-raising, therefore various strategies are established to ensure production: distribution of the

flock between the members of the household in order for each to try their luck; and a limit on the consumption of chickens and eggs. In the long term, success in vaccination against the disease may modify both the conceptions and the practices which exist at present. Although resistance to a substantial increase in consumption of chickens has been acknowledged, their greater availability implies an increase in their consumption. Greater access to animal protein improves the household diet and the nutritional status of its members. For all households, but especially for the poorest and for women who rely mainly on chickens to fulfil their basic needs, the increase in the total numbers of chickens raised represents a small improvement in diet, hygiene, clothing, medications, schooling and the possibility of getting access to a prized meal and to money.

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# Village Poultry Production in Mozambique: Farming Systems and Ethnoveterinary Knowledge in Angonia and Tsangano Districts, Tete Province

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## *Abstract*

A participatory questionnaire was used to study small stock farming systems and ethnoveterinary knowledge in two districts in the centre of Mozambique where many farmers were returning to their land after the end of the civil war. Eighty nine per cent of farmers kept village chickens with an average flock size of 14 birds. The majority of farmers provided housing and supplementary feed for their chickens. Reproduction was highest in the period from April to July. Constraints to village chicken production included Newcastle disease (ND), cold weather, lice, fleas and fowl pox. Traditional remedies for ND are presented.

A PARTICIPATORY questionnaire was used to collect information on farming systems and traditional methods of small stock production in the districts of Angonia and Tsangano in Tete Province in May, 1996 (Harun and Massango 1996). These districts are situated in the north of the province, adjacent to the border with Malawi, at an altitude of more than 1000 metres. December, January and February are the wettest months of the year. In 1996, the human population of Angonia District was approximately 300 000 and 100 000 in Tsangano District.

The civil war, which ended in October 1992, had a negative impact on numbers of farmers and animals, and on disease prevalence in this region. About 98% of farmers left their villages and 90% took refuge in neighbouring countries.

## **Ownership patterns and flock sizes**

Eighty nine per cent of the farmers owned chickens (Table 1) and chickens were considered by farmers as their most important livestock species. Small stock ownership was greater in female-headed households (Table 2). Household flock size varied from 11 to 17

birds (average 14). Village flock composition is shown in Table 3. Traditional restocking is a common practice. This helps to reduce risk due to disease, and assists others to build up their flocks. Although there are small variations in the way it is carried out, the most common procedure is as follows: the owner (or donor) hands over a pair of chickens to the beneficiary (or recipient). The beneficiary is obliged to take care of the birds for two successive hatchings. The beneficiary then returns all chicks to the donor as 'payment' for the pair. In general, women take care of the chickens.

## **Housing**

Most farmers provide housing for their chickens. Houses are built to protect the birds from predation (by winged or four and sometimes two legged creatures), to control egg production and to keep the birds away from the fields during the planting season. Chickens are released from their houses during the day and allowed to scavenge, and are enclosed at night.

Basically, there are three types of housing. Houses at ground level are usually made from mud, rocks or baked bricks, with a roof made of straw. They may be situated in the backyard of the family house or attached to the verandah of the house. The entrance to these houses is only large enough to permit the

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**Table 1.** Ownership patterns of the various livestock raised in each of the four villages in the study area.

Type of animal	Name of village								Total	
	Dzimeza		Ligoe		Matewere		Mbemba		No.	%
	No.*	%	No.	%	No.	%	No.	%		
Ducks	3	10%	3	10%	6	17%	5	14%	17	13%
Rabbits	2	6%	1	3%	5	14%	5	14%	13	10%
Goats	16	52%	8	28%	9	26%	14	40%	47	36%
Pigs	19	61%	6	21%	13	37%	19	54%	57	44%
Guinea pigs	1	3%	1	3%	1	3%	1	3%	4	3%
Cattle	8	26%	6	21%	6	17%	1	3%	21	16%
Pigeons	8	26%	3	10%	4	11%	4	11%	19	15%
Total	31		29		35		35		130	

\* Number of respondents.

entry of chickens and prevents the entry of many predators, especially dogs and hyenas. However, the interior is generally small and dark, making access for cleaning difficult. Houses of this type do conserve heat, which is especially important in the colder seasons.

**Table 2.** Gender disaggregated ownership patterns of livestock in the study area.

Type of animal	Gender of head of household				Total	
	Female		Male		No.	%
	No.*	%	No.	%		
Chickens	15	94%	101	89%	116	89%
Ducks	3	19%	14	12%	17	13%
Rabbits	1	6%	12	10%	13	10%
Goats	5	31%	42	37%	47	36%
Pigs	3	19%	54	47%	57	44%
Guinea pigs	2	12%	2	2%	4	3%
Cattle	2	12%	19	17%	21	16%
Pigeons	1	6%	18	16%	19	15%
Total	16		114		130	

\* Number of respondents.

Elevated houses may be made of bamboo, reeds and straw. They are usually raised about one metre above the ground and a small ladder or simple pole is provided to allow birds access. Houses of this type are easy to clean and provide good protection from predators (except snakes). However, this type of house is unsuitable for hens with chicks.

Enclosures are sometimes made for chickens under maize granaries. These protect the birds from predators. Rocks or baked bricks are laid around the perimeter of the granary, leaving a small opening to the interior.

### Nutrition

In contrast to the common perception that village chickens subsist on what they can catch and on their luck, the chickens of these districts are fed once or twice a day. The supplementary feed supplied is usually maize waste or meal. This ration is a source of energy. The protein and vitamin requirements of the birds must be met by scavenging.

### Reproduction

The harvest season from April to July is the time of highest production. This is shown by peak egg

**Table 3.** Numbers of village chickens by category raised in each of the four villages in the study area.

	No. of chickens		Cocks		Hens		Chicks	
	No.*	Number	No.	Number	No.	Number	No.	Number
	Dzimeza	26	436	18	43	26	160	21
Ligoe	28	474	21	35	27	235	20	205
Matewere	33	383	22	40	33	181	24	162
Mbemba	29	378	16	27	29	135	21	212
Total	116	1671	77	145	115	711	86	822

\*Number of respondents.

production (mean 11 eggs), high hatchability (78%, with about 8–9 chicks hatched) and high chick survival rate (66%, about 5 chicks alive in February to June). The survival rate is influenced by the colour of the chick and the extent of vegetation cover, which is dependent on the rainfall.

Lowest production occurs from July to December. During this period, there is low hatchability, low chick survival rate (due to winds in July and August, and rain in November and December), predation (natural protection provided by vegetation is absent), and ND (September and October). Consequently, flock size is small (December and January); there is low egg production due to ND and shortage of feed. Consequently, there is an increased demand for and price of chickens and their products.

### Constraints to Production

In these districts, the principal diseases in order of importance to the farmers are:

- *Dzowe* or *Chitopa* (Newcastle disease; ND), which traditionally occurred twice per year (March/April and September/October). More recently, farmers report that the disease occurs all year round, sometimes causing mortality of up to 100%.
- *Mphopo* (Cold), which is associated with the windy months of July and August. This disease causes high mortality in chicks hatched during this season.
- *Chidelu* which causes sudden deaths in chickens. No clinical signs are observed.
- *Utibili* – lice infestation of chicks.
- *Madzedze* – infestation with fleas. Fleas affect mainly the unfeathered areas of the bird behind the eye. Farmers control fleas with an application of kerosene (paraffin oil).
- *Chikwirikwiti* (Fowl Pox) is manifest by the appearance of lesions on all parts of the head, especially on the unfeathered areas, and swelling of the head and eyes.

Losses due to predators are also significant and markedly reduce village chicken production. Predators include dogs, rats, owls and eagles, hyenas, wild cats, squirrels and thieves. Farmers prefer dark coloured or black birds to reduce losses due to predators. Many farmers know that diseases and parasitic problems are associated with poor hygiene and cleaning.

### Indigenous Knowledge

Ethnoveterinary or indigenous knowledge includes local traditional methods for caring for, healing, and managing livestock and includes social practices and ways in which livestock are incorporated into

farming systems. It is based on community knowledge (experience) and is relevant for developing countries due to its low cost and the availability of traditional healers, who live locally. In addition, the poor can afford to pay in kind. However, the effectiveness of many treatments and practices is yet to be validated and the scientific background of such treatments and practices is not fully understood.

Some farmers have used various traditional medicines to treat ND, but the results are unsatisfactory. Table 4 shows some of the traditional remedies used to treat ND in various areas of Mozambique.

**Table 4.** Traditional knowledge of ND control.

Province	ND local names	ND local treatments
Tete (Angónia e Tsangano District)	<i>Dzowe</i> <i>Chitopa</i>	<i>M'pinjipinji</i> (Root) <i>Chitedze</i> (Root) <i>Muyimbi</i> (Bark) <i>Mkhunga</i> — <i>Mata-peixe</i> (Tuber) <i>Khonje</i> — Aloe — Leaf <i>M'chemani</i> — (Bark) <i>M'gundanjonvu</i> — <i>Mata-peixe</i> (Root) <i>M'valankhunda</i> (Root) <i>Matitidza</i> (Root) <i>Chikumasi</i> (Root) <i>Chizuzu</i> — <i>Mata-peixe</i> (Tuber)
Manica	<i>Chigubo</i> – <i>Gubo</i>	<i>Uepa</i> (Bark)*
Maputo Inhambane	<i>Muzungu</i> <i>Mbendeni</i> and <i>Quitjuku</i>	<i>Intxikile</i> (Root)* <i>Kulikwa</i> (Fruit)* Chillies and garlic*

\* From Alders et al. 1999.

### Conclusions

Farmers want to increase their flock size and are aware that traditional treatments for ND are not 100% effective. However, they do not have sufficient knowledge and confidence in the use of vaccines against ND. They are willing to pay the cost of the ND vaccine.

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# Sustainable Control of Newcastle Disease in Rural Areas

R.G. Alders<sup>1</sup>

## *Abstract*

In areas where the cold chain is non-existent or unreliable, Newcastle disease (ND) can be controlled in village chickens using thermostable ND vaccines. In order for ND control programs to be sustainable, the technical, social, cultural, administrative and economic issues such as community participation, gender sensitive extension activities, facilitating government policies, training of staff and farmers, cost recovery, and distribution and marketing networks must be addressed. 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 to ensure that the control of ND will make an ongoing contribution to the well-being of village chicken farmers and their families. Areas that lack a reliable cold chain are frequently characterised by a lack of infrastructure in general and limited human resource capacity. Therefore, the vaccination of chickens must be accompanied by appropriate organisational, communication and economic practices.

IN MANY developing countries, the type of livestock most commonly owned by rural families is chicken. Many of these families will be resource poor, many may be headed by women. Increasing the productivity of their chickens will make a significant contribution towards increasing their food security and their ability to have secure livelihoods because of the multi-functional roles of local chickens. Village chickens provide meat and eggs, food for special festivals, offerings for traditional ceremonies, pest control and petty cash (for instance, to purchase medicines or pay school fees) (Alders and Spradbrow 2000)

The number of malnourished children in many developing countries is unacceptably high and demonstrates the prevailing food insecurity in these countries. This situation has wider implications for development because protein-energy malnutrition in children below the age of 5 years inhibits their growth, increases their risk of illness, affects their mental development, and reduces their subsequent school performances and labour productivity (Pinstrup-Andersen et al. 1993).

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% of daily protein requirements and 5% 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 2000). They are the livestock most likely to be owned and cared for by women and children (Guèye 2000; Spradbrow 1993–94).

In most developing countries, the major constraint to village chicken production is Newcastle disease (ND) (Alexander 1991; Spradbrow 1988). This disease can cause up to 100% 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

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money in improving the standard of their poultry husbandry (Spradbrow 1996).

In areas where ND is endemic, control of the disease will result in substantial increases in village chicken numbers (Alders et al., these Proceedings; Dias et al. 2000). 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, facilitating 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 so adopt new technologies only once they are sure of an adequate return on their investment of both time and money (AFFHC 1987).

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 of chickens must be accompanied by appropriate organisational, training, communication and economic practices.

### **Organisation**

Farmers, extension workers, veterinary services staff, private business people (including chicken traders), livestock and social scientists and non-governmental organisations (NGOs) will make up the stakeholders who should be involved in ND control activities from the outset. All stakeholders must work together to ensure that a suitable vaccine is available at the required time in the field, 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 your success. In most cases, farmers will be expected to pay for the ND vaccine and so it is critical that the first vaccination is a success. Most farmers will not grant you a second chance. 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 2000)

### **Community participation**

It is the farmers who are the clients of the ND control program and the program 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 trialed with representative groups of farmers.

In addition, it is essential that farmers not be seen as a homogeneous group. Demographic studies should be done to determine the various groups involved with village chicken production, and methods used 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 linkages 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 programs.

#### **Coordination between government and the private sector**

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. 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.

#### **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. 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 that accrue 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 that focus on ND and village chicken production (Alders and Spradbrow 2000; IAEA 1999). 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, newspapers, group meetings, field days and school lessons. An example of the package produced in Mozambique is given in a separate paper in these Proceedings (Alders et al., these Proceedings). 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 ethno-veterinary knowledge and participatory technology development. Care must be taken to ensure that participatory techniques are used in a gender-sensitive manner. Regular analysis of farmers' perception of the ND control program should be conducted and take into account other household activities. Participatory methodologies that can improve our understanding of village poultry farmers and village poultry production are discussed elsewhere (Alders and Spradbrow 2000).

The frontline extension staff must be encouraged to actively 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 clearly show that participatory techniques are not automatically gender-sensitive (Gujit 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, we need to learn who does what and then help them do it better. Collecting gender disaggregated data helps us to determine how the tasks associated with village poultry production are divided within households (Alders and Spradbrow 2000). It is well known that direct communication with the person who actually does the work is more effective.

#### *Clear consistent messages*

With regards 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 before 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 cheap ways. The amount is insignificant compared to actual production costs and it can actually save money by avoiding the production of materials that are not understood or accepted. (Bertrand 1978; Dudley and Haaland 1993; Haaland 1984)

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 help bring 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 program for extensionists 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 (Alders and Spradbrow 2000). In the early stages of the ND control program, the refresher courses provide an opportunity for trainers to get feedback from the field on how the training can be improved.

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.

## **Vaccination**

### **Vaccine selection**

Bell has reviewed the advantages and limitations of the different vaccines available for use against ND in village chickens elsewhere in these Proceedings. 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 will 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 such as ITA-NEW and Newcavac. In most cases where farmers are to contribute wholly or partially to the cost of the vaccine, the price of the vaccine will be a major factor. The lower the price of the vaccine, the greater the number of farmers who will be able to afford to pay for it and, consequently, the greater the vaccination coverage. The lowest cost thermostable ND vaccine is generally locally produced I-2 'wet' vaccine. Locally produced freeze-dried I-2 ND vaccine is usually cheaper than imported freeze-dried live and inactivated thermostable 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 conducted 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 opt to produce the ND locally.

#### *Local production*

ND vaccine of a quality acceptable for use in village chickens can be produced in the laboratories of some developing countries as documented elsewhere in these Proceedings (Alders et al.; Buza and Mwamhehe; Dias et al.; Tu). In these cases, the vaccine is produced in eggs that 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 much less foreign exchange.

Where funding is not limiting, then it is best to use SPF eggs or high quality minimum disease free 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 that currently produce the NDV4-HR vaccine provided foreign exchange issues are not a limitation (Alders and Spradbrow 2000). 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. Countries 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.

#### **Distribution**

A distribution system that makes the vaccine available when farmers need it and enables 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. In such situations, it is best to consider conducting ND vaccination campaigns. Campaigns should be carried out during particular months during of the year and every effort made to ensure that the vaccine is available locally in the period immediately before the start of the campaign. For instance, in Mozambique, it is recommended that the I-2 ND vaccine be administered via eye-drop in March, July and November. Ensuring that the freeze-dried I-2 vaccine (which it is recommended be held outside refrigeration for no longer than 2 months) is available at the district level in the month before the campaigns is a major task. 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 be pursued in the field at the same time that ND vaccination commences. One group of people who travel regularly from towns to the villages is the chicken traders. Would it be possible for them to take vaccine out to the villages?

Where the cold chain is lacking at the level of the farmers' household only, then the ND vaccine may

be held in stock locally and purchased by farmers and vaccinators as required. In ND endemic areas, if farmers are able to vaccinate their flocks four times a year rather than 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 periodical testing to confirm that it stills 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.

### **Administration**

Specific details concerning the standard dose, administration routes and vaccination schedules for the I-2 ND vaccine are presented elsewhere in these proceedings (Alders et al. these Proceedings). The range of information presented on the I-2 ND vaccine may serve as a template for the information required by field workers irrespective of the ND vaccine in use.

Consideration needs to be given to who should administer the vaccine to the village chicken. 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 increasing the knowledge and expertise of farmers.

#### *Community vaccinators*

The selection of community vaccinators will be critical to the success of the control program. 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. It is the protection of their own chickens that is of most 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.

### **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.

In some countries, the government agencies involved in the production and distribution of the ND vaccines are required by law to send all income to the central treasury. Consequently, the production or purchase of vaccine relies on the release of funds from central government, a process that is frequently slow and bureaucratic. It would be more efficient if the relevant agencies were permitted to establish their own revolving funds that are subject to annual audits.

#### **Cost minimisation**

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 minimisation 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.

#### **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 are augmented. 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 these Proceedings).

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. Community benefits will be further increased if some community members become chicken traders supplying 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 before 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 is held in the country. Much of the costs associated with local production stay in the country as only some of the inputs need to be imported. The instructions that accompany the vaccine are produced in the national 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 (these Proceedings), most mixed farmers seek to increase the number of livestock species that they raise when surplus numbers of chickens permit such purchases.

## Conclusion

The sustainable control of ND in village chickens will not be achieved easily. However, the empowerment and financial benefits that it gives to village chicken farmers make it well worth the effort. It is also hoped that the mechanisms put in place will reduce the lag time required for the introduction of other activities that will further increase village poultry production.

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# Laboratory and Field Trials with Thermostable Live Newcastle Disease Vaccines in Mozambique

P.T. Dias, R.G. Alders, R. Fringe and B.V. Mata<sup>1</sup>

## *Abstract*

The Australian strains of avirulent, thermostable Newcastle disease virus designated NDV4-HR and I-2 were tested in the laboratory and under field conditions in Mozambique. An overview of this work is presented. Under experimental conditions, both vaccine strains provided protection to all vaccinated birds and those in contact with them against a local virulent strain of ND virus, V868. Field trials confirmed these results. In addition, it was shown that vaccine administered by eye-drop gave better results than vaccine administered in the drinking water or by oral drench. There were no adverse reactions to the vaccines and it was concluded that NDV4-HR and I-2 strains are avirulent, innocuous, efficacious, immunogenic and suitable for use in the control of ND in Mozambique. Factors contributing to the successful implementation of the field trials are also discussed.

NEWCASTLE DISEASE (ND) is endemic in Mozambique, occurring every year in the rural poultry sector (National Directorate of Livestock 1992). Although few surveys of the prevalence of Newcastle disease (ND) in Mozambique have been undertaken, available information indicates that this disease is the most important constraint to the rearing of rural chickens (Fringe and Dias 1991; Mavale 1995; Wethli 1995).

Vaccination is the most effective means of controlling ND and has been used successfully throughout the world since the 1940s (Beard and Hanson 1984). In 1955 the National Veterinary Research Institute (INIVE) in Maputo commenced production of attenuated, live ND vaccines and has produced vaccines based on strains F, B1, La Sota and Komarov. These vaccines are used mainly in the commercial poultry sector. They are of limited application in rural areas due to problems of heat lability of the vaccine strain, large dose presentation, affordability, and shortage of government staff, transport and cold chain for effective administration of the vaccine.

The avirulent, thermostable ND vaccine strains NDV4-HR (Ideris et al. 1987) and I-2 (Bensink and

Spradbrow 1999) were developed by researchers at The University of Queensland in Australia to provide rural poultry farmers with an effective, affordable means of controlling ND in their flocks. These vaccines have been used successfully in village chicken populations in many countries in Asia and Africa. In 1996, The Australian Centre for International Agricultural Research (ACIAR) project AS1/96/96 commenced with the major objective of producing I-2 vaccine and testing its use in the sustainable control of ND in rural areas of Mozambique. Initial laboratory and field trials were conducted using NDV4-HR since this was available commercially and could easily be replaced by I-2 once local production commenced. This paper briefly describes the results of the laboratory and field trials with NDV4-HR and I-2 vaccines and describes the activities undertaken to ensure the successful implementation of the field trials.

## **Materials and Methods**

### **NDV4-HR vaccine laboratory and field trials**

NDV4-HR vaccine was supplied by Fort Dodge Pty. Ltd, Australia, as infected allantoic fluid in lyophilised form and was reconstituted and diluted in potable water prior to use.

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### Laboratory trials

Commercial broiler day old chickens were purchased locally. At three weeks of age, the birds were tagged individually with numbered wing tags and randomly allocated into three experimental groups (Figure 1). Ten birds (vaccinated, group 1a) were vaccinated with  $10^6$  EID<sub>50</sub> via eye-drop on two occasions two weeks apart. They were housed with a group of six unvaccinated (in contact) birds (in-contact, group 1b). Two weeks after the second dose of vaccine, all birds were challenged by contact with five non-vaccinated birds which had been inoculated intranasally with a local virulent isolate of ND virus (directly challenged, group 1c).

Non-vaccinated control birds were housed separately and attended by a different technician. This group was challenged by randomly selecting five birds (group 2b) that received a suspension of challenge virus intranasally and kept in contact with group 2a consisting of the 13 other non-vaccinated birds.

All birds were observed for clinical signs during the vaccination and challenge periods, and number of deaths in each group was recorded.

Serum was collected at key stages of the laboratory trial and from all surviving birds but the results of the haemagglutination inhibition (HI) tests will not be presented in this paper.

At the end of the laboratory trial, the extensionists and district livestock officer from the field trial site

were invited to INIVE to participate in the clinical and post mortem examination of trial birds. The clinical signs and lesions of ND were demonstrated, and the efficacy of the vaccine against a local virulent strain of ND virus demonstrated.

### Field trial

Five hundred chickens in each of three villages were vaccinated with the NDV4-HR vaccine administered by community assistants. A different route of administration was used in each village: eye-drop, oral drench and drinking water. In a fourth village, approximately 500 chickens were mock-vaccinated with water and served as controls. The dose rate was one drop of vaccine ( $10^6$  EID<sub>50</sub>) per bird every four months. Approximately 10% of birds in each group were identified using individually numbered wing tags and serum samples were collected from each bird. Monthly serum samples were collected from approximately 20 identified birds from each group for titration of HI antibodies. The status of individually tagged birds and the number of birds per household were recorded every two weeks over a 12-month period. Postmortem samples from dead birds were subjected to ND virus isolation.

### I-2 Vaccine laboratory and field trials

The vaccine strain I-2 was supplied by the Virus Laboratory, the University of Queensland, Australia. It was propagated in 9-day-old embryonated chicken

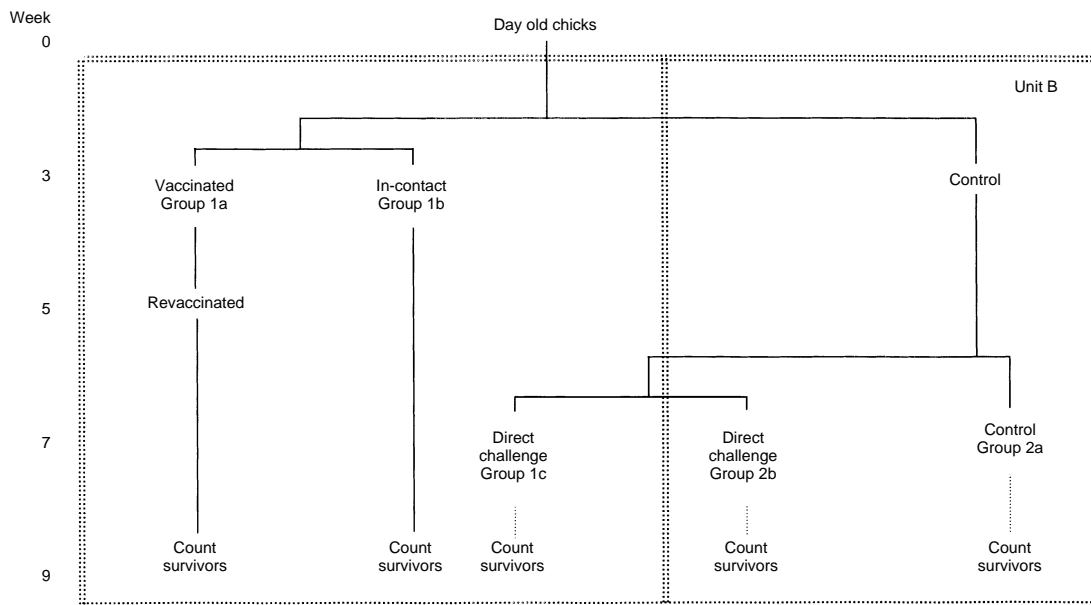


Figure 1. Design of NDV4-HR and I-2 vaccine laboratory trials. The double line indicates the separate housing of the groups.

eggs (from a minimum disease free flock) at INIVE, Maputo, Mozambique. The vaccine was prepared as a wet vaccine (Spradbrow et al. 1995).

#### *Laboratory trial*

Day old chickens were purchased from a local commercial hatchery and raised in the isolation unit at INIVE. After three weeks they were identified with individual numbered wing tags (Figure 1), randomly divided into groups and serum was collected to determine the level of antibodies against ND.

Ten birds (vaccinated, group 1a) were vaccinated with  $10^6$  EID<sub>50</sub> via eye-drop, on two occasions two weeks apart. The first vaccination was given at three weeks of age. The in-contact group (1b) consisting of six unvaccinated birds was kept in contact with the vaccinated group (1a). Serum was collected from the birds two weeks after the second dose of vaccine to determine the level of antibodies to ND. The vaccinated (1a) and in-contact (1b) groups were challenged immediately following serum collection by contact with an unvaccinated group of 5 birds (group 1c) which had been inoculated via eye-drop with virulent ND virus.

Unvaccinated control birds were housed separately and attended by a different technician. This group was challenged by randomly selecting five birds (Group 2b) that received a suspension of challenge virus via eye-drop and kept in contact with group 2a consisting of the 20 other non-vaccinated control birds. The number of birds that survived challenge was recorded.

Serum was collected at key stages of the laboratory trial and from all surviving birds but the results of the haemagglutination inhibition (HI) tests will not be presented in this paper.

#### *Field trial*

From 70 to 230 chickens in each of three villages were vaccinated against ND using the wet I-2 vaccine administered by community assistants. In each village, a different route of administration was used: eye-drop (once only); eye-drop (twice, three weeks between doses) and drinking water. In a fourth village, approximately 200 chickens were mock vaccinated as controls. In each group, about 10% of chickens were identified using numbered wing tags and serum samples collected. Approximately 30 serum samples were collected from each group of identified birds four to seven weeks after vaccination depending on the treatment group. Fewer serum samples were collected from the control group as a ND outbreak commenced shortly after the start of the trial and greatly reduced chicken numbers in the control area. The status of individually tagged birds and the number of birds per household were recorded every two weeks over a five-month period.

#### *Serology*

HI titres were measured on the day of vaccination and at monthly intervals during the field trials. The HI test was performed using four HI units of NDV4-HR virus strain and a 1% suspension of chicken red blood cells (Allan and Gough 1974). Tests were conducted on sera collected before and after vaccination. Sera were subjected to doubling dilutions eight times and for statistical purposes all sera with titres equal to or greater than 8 (log to base 2) were given a value of 8.

#### *Challenge virus*

The virus used as the challenge virus was isolated by the Virology section at INIVE from birds in the commercial sector that had died of ND. The reference material, designated V868, was passaged twice in 9-day-old embryonated chicken eggs from a minimum disease free flock. The average time for embryo death (mean death time) was 51 hours. Birds inoculated directly with the virus received a dose of  $10^{7.7}$  ELD<sub>50</sub> in the NDV4-HR vaccine laboratory trial and  $10^7$  ELD<sub>50</sub> in the I-2 vaccine laboratory trial.

#### *Pre-trial activities*

Experimental sites were selected in collaboration with National Directorate of Rural Extension at meetings of project staff with the chiefs of Provincial Veterinary Services and with the Provincial Rural Extension Service.

All fieldwork was conducted in collaboration with the District Extension and Livestock Services. Meetings were held with the community leaders and village poultry farmers to discuss the objectives of the trial, to explain that some groups of birds would probably not be protected by the vaccine and that the vaccine would only protect against ND. The need for collecting blood samples and using wing tags to identify trial birds was also discussed. Members of the community approved the proposal and volunteered to cooperate with the investigation.

A questionnaire was designed to collect information on poultry husbandry practices and problems in the trial area. The questionnaire was prepared in both Portuguese and Shangana (the local language) with the help of the Poultry Working group that consisted of representatives of INIVE, Rural Extension, Institute of Animal Production, Veterinary Faculty, Institute of Rural Development and Provincial Service of Agriculture in Maputo.

An assistant was selected from each community with the assistance of community members and trained to carry out the village poultry survey, collect data on chicken numbers, health status and production in each participating household, and the seasonal

occurrence of ND outbreaks. Trial groups were allocated randomly by a lottery draw at a community meeting.

Comprehensive records of meetings, decisions, vaccine used and participating farmers were kept. A form of compensation or incentive for participating farmers was also discussed. To avoid disrupting normal village activities, all meetings, vaccinations and blood collection were arranged at times suitable to the farmers.

#### *Trial extension activities*

During the trial, monthly meetings were held with the leaders and members of the community, and local assistants to present the results of serological monitoring, to discuss the health status of poultry in the trial sites and to encourage continued cooperation.

## Results

### NDV4-HR

#### *Laboratory trials*

No signs of clinical illness were observed in any of the vaccinated birds or birds in contact with them after vaccination or challenge, and all survived challenge with the virulent ND virus V868. All chickens in group 1c (100%) and four chickens in group 2b (80%) died after challenge with V868 ND virus showing typical clinical signs and lesions of ND. All 13 birds challenged by contact (group 2a) also died (100%). Results are shown in Table 1.

**Table 1.** Results of the vaccine laboratory trial conducted using NDV4-HR vaccine in broilers in Mozambique.

Group	No. of chickens per group	Vaccination procedure *	Challenge procedure **	No. of survivors/No. challenged	Mortality (%)
1a	10	ED	IC-1c***	10/10	0
1b	6	IC	IC-1c	6/6	0
1c	5	Nil	IN	0/5	100
2a	13	Nil	IC-2b#	0/13	100
2b	5	Nil	IN	1/5##	80

ED – Eye-drop.

IC – In contact.

IN – Intranasal.

\* –  $10^6$  EID<sub>50</sub>.

\*\* –  $10^{7.7}$  ELD<sub>50</sub>, Local isolate No. V868.

\*\*\* – In contact with group 1c.

# – In contact with group 2b.

## – The chicken that survived the challenge demonstrated clinical signs of Newcastle disease, developed an elevated HI titre and remained uncoordinated at the end of the trial.

#### *Field trials*

Administration of NDV4-HR by eye-drop provoked a greater antibody response than administration via drinking water or oral drench (Table 2). More birds vaccinated by eye-drop survived an outbreak of ND than birds vaccinated by the other routes and this group also showed the greatest population increase after 1 year. Results are shown in Table 3.

**Table 2.** Geometric mean HI titre (log to base 2) of tagged birds on day 0 and day 30 of the NDV4-HR vaccine field trial.

Route of vaccination	GMT day 0	GMT day 30
Eye-drop*	3.6	6.0
Oral drench*	3.0	4.3
Drinking water*	1.9	3.9
Control	3.3	3.4

GMT – Geometric mean titre (log to base 2).

\* – NDV4-HR vaccine administered once.

**Table 3.** Survival of tagged birds to six months and changes in the chicken population to 12 months of the field trial with NDV4-HR vaccine.

Route of vaccination	Survival of tagged birds to 6 months	Changes in general chicken population after 1 year
Eye-drop*	77%	+144%
Oral Drench*	56%	+25%
Drinking Water*	50%	-22%
Control	32%	-46%

\* – NDV4-HR vaccine administered once every four months.

Of the birds vaccinated with NDV4-HR vaccine by eye-drop, an additional 17% were slaughtered for consumption and 6% were stolen, sold, lost or transferred to another area. Of birds vaccinated via drinking water and oral drench, an additional 5% and 2% respectively were stolen, sold, lost or transferred to another area. No birds in these groups were slaughtered. In the control group, 10% of birds were slaughtered, stolen, sold, lost or transferred to another area.

Virulent ND virus was isolated during the natural outbreak that occurred during the field trial.

## I-2

#### *Laboratory trials*

No adverse reactions to the vaccine were observed in vaccinated and in contact birds. I-2 induced HI

antibodies in these birds and the level of HI antibody and survival after challenge were positively correlated. All vaccinated and in contact birds survived challenge. In contrast, all birds in groups 1c, 2a and 2b died between 4 and 6 days after infection showing typical clinical signs and lesions of ND. Results are shown in Table 4.

**Table 4:** Results of the vaccine trial using the heat-tolerant I-2 vaccine against Newcastle disease in broilers in Mozambique.

Group	No. of chickens per group	Vaccination procedure *	Challenge procedure **	No. of survivors/No. challenged	Mortality (%)
1a	10	ED	IC-1c***	10/10	0
1b	6	IC	IC-1c	6/6	0
1c	5	Nil	ED	0/5	100
2a	16	Nil	IC-2b#	0/16	100
2b	5	Nil	ED	0/5	100

ED – Eye-drop.

IC – In contact.

\* –  $10^6$  EID<sub>50</sub>.

\*\* –  $10^7$  ELD<sub>50</sub>, Local isolate No. V868.

\*\*\* – In contact with group 1c.

# – In contact with group 2b.

#### Field trials

The questionnaire showed that ND was considered by farmers to be the most important constraint to village poultry production.

Administration of the vaccine by eye-drop provoked a higher antibody response than administration by drinking water, with little difference between birds vaccinated once or twice (Table 5). After five months, there were marked differences in chicken numbers between treatment groups. Results are shown in Table 6.

**Table 5.** Geometric mean HI titre (log to base 2) of tagged birds on day 0 and day 30 of the I-2 vaccine field trial.

Route of administration	GMT Day 0	GMT 30 days post vaccination
Eye-drop (twice)*	3.8	7.1
Eye-drop (once)**	3.3	6.6
Drinking water*	4.8	6.3
Control	2.6	2.0

GMT – Geometric mean titre (log to base 2).

\* – I-2 vaccine given on two occasions, 3 weeks apart.

\*\* – I-2 vaccine given once.

**Table 6.** Survival of tagged birds and changes in the chicken population at the end of the five month field trial with I-2 vaccine.

Route of vaccination	Survival of tagged birds	Change in general chicken population (%)
Eye-drop (twice)*	83%	+54%
Eye-drop (once)**	82%	+50%
Drinking water*	65%	+17%
Control	0%	-71%

\* – I-2 vaccine administered twice, three weeks apart at the start of the trial and then given once every 4 months.

\*\* – I-2 vaccine administered once only with revaccination occurring after 4 months.

Of the birds vaccinated twice with I-2 vaccine by eye-drop, an additional 6% were slaughtered for consumption and 9% were stolen, sold, lost or transferred to another area. 4% of birds vaccinated once by eye-drop were slaughtered for consumption and 10% were stolen, sold, lost or transferred to another area. Of the birds vaccinated via drinking water, an additional 12% were stolen, sold, lost or transferred to another area. In the control group, 10% of birds were slaughtered, stolen, sold, lost or transferred to another area.

#### Discussion and Conclusions

Laboratory trials showed that chickens vaccinated with NDV4-HR and I-2 vaccines were protected against a local virulent isolate of NDV. The virus strains were transmitted by contact between chickens and provoked no clinical response in vaccinated or in contact birds. This is in agreement with other laboratory trials with NDV4-HR vaccine in Zambia (Alders et al. 1994) and with I-2 vaccine in Vietnam.

The results obtained in the field trials show that the vaccines can be successfully administered via different routes. In each trial, the highest titres were achieved in the groups where the vaccine was administered via eye-drop. The vaccination regime employed in the NDV4-HR vaccine field trial was unusual in that the vaccine was given once only every four months for each route of administration. This was done to determine the most economically viable strategy for vaccination. After a natural outbreak of ND, it was clear that eye-drop was the only administration route that gave adequate protection when employing such a vaccination regime. Bell et al. (1995) found that a single eye-drop administration of NDV4-HR vaccine provided acceptable protection of village chickens in Cameroon.

In both trials, approximately 80% of chickens vaccinated via eye-drop (irrespective of whether the vaccine was administered once or twice initially) survived natural challenge with virulent ND virus. When the vaccine was administered twice via drinking water, a survival rate of 65% was achieved. Although protection of 60% of birds in a village is considered sufficient to limit the propagation of ND outbreaks, the protection of 60% of birds within a household was rarely acceptable to the farmers concerned.

Although eye-drop administration requires that each bird be caught, this was the method preferred by farmers because of the better protection experienced when this route of vaccination was used. As farmers gain confidence in the ND control activities, they should be encouraged to improve the housing provided for their chickens. Improved housing will facilitate the catching of birds for eye-drop administration of the ND vaccine and should reduce losses due to predation. Bell et al. (1995) also recommended improved housing for village chickens, especially for young chicks up to four weeks of age, as this was the group that suffered the highest losses from predation.

There was little difference in antibody response and survival after challenge between birds vaccinated once or twice with I-2 by eye-drop. The results also clearly indicate that eye-drop administration is more effective than oral vaccination when vaccine is given once every four months. Application by drinking water is easier especially where around 50% of birds are housed but regrettably, this route provokes a lower level of immunity.

Successful implementation of field trials depended on good laboratory-field communications. Pre-trial planning and extension were crucial to ensure farmer cooperation in these trials, and in any future vaccination programs.

A strategy for the control of ND in village chickens must be economically feasible. The costs associated with vaccination campaigns are purchase of the vaccine, transport and administration of the vaccine. Therefore, less frequent but effective vaccination is preferred. If the seasonal prevalence of ND is known, vaccination campaigns can be timed appropriately. Currently in Mozambique vaccination with I-2 vaccine via eye-drop is recommended every four months in village chickens.

## Acknowledgments

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# Characteristics of the I-2 Live Thermostable Newcastle Disease Vaccine Produced at INIVE

R.G. Alders, R. Fringe, and B.V. Mata<sup>1</sup>

## *Abstract*

The I-2 thermostable live Newcastle disease vaccine was successfully produced and tested at the National Veterinary Research Institute in Mozambique. Local production of the vaccine has facilitated the supply of a low-cost, thermostable ND vaccine suitable for use in the control of ND in village chickens. For the vaccine to be used successfully in the field, the development of appropriate extension material and methods for veterinarians, extension workers and farmers was essential. All accompanying materials have been written in Portuguese with translation into local languages occurring in the field. The characteristics of the I-2 vaccine were defined to provide answers to the practical 'how to' questions posed by users in the field.

THE I-2 Newcastle disease (ND) vaccine produced at INIVE performed well in laboratory and field trials (these trials are described elsewhere in these Proceedings). The seed vaccine was supplied by the Department of Veterinary Pathology of The University of Queensland, Australia. It was essential that the characteristics and performance of the vaccine be well understood to facilitate the development of an appropriate extension package to enable the vaccine to be used effectively.

## **Characteristics of the I-2 Vaccine and Recommendations For Use**

### **Thermostability**

The I-2 vaccine will retain its activity for 8 weeks at 28°C when in freeze-dried form and stored in the dark. 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, i.e. one cannot expose the vaccine to sunlight and frequent shifts in temperature and still expect it to remain active.

### **Storage and transport conditions**

If users have access to normal cold chain facilities, then these should be used, even when dealing with a thermostable vaccine. 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, place it in a cool box with ice or an ice pack. DO NOT FREEZE the vaccine. The freeze-dried I-2 vaccine is packed under vacuum rather than with nitrogen and so 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.

If an adequate cold chain does not exist, then the vaccine should be stored in a cool, dark place (such as beside the base of a clay water pot). Record the date the vaccine leaves the cold chain, as it will remain effective for 2 months only. When transporting the vaccine in the field, wrap it in a damp cloth and carry it in a covered open-weave basket. This allows evaporative cooling which helps to keep the vaccine cool and the cover prevents exposure to sunlight.

### **Administration**

#### *Standard dose*

As with other live ND vaccines such as La Sota, a minimum of 10<sup>6</sup> EID<sub>50</sub>/bird is required to produce an

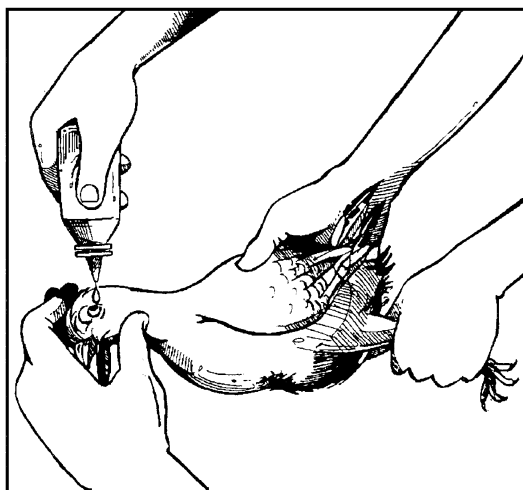
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<sup>1</sup> National Veterinary Research Institute, C.P. 1922, Maputo, Mozambique

adequate level of protection. It has been demonstrated that birds that received a higher oral dose of the similar NDV4-HR vaccine generated a higher immune response when confined in cages with wire floors (Spradbrow et al. 1988). Under village conditions where birds are not housed, 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.

#### *Administration routes*

The I-2 vaccine can be administered via eye drop, drinking water, certain feeds and injection (Alders and Spradbrow, these Proceedings). Field trials in Mozambique indicated that almost all farmers preferred eye drop administration even though it required the capture of birds. In their opinion, eye drop administration of the vaccine produced a greater survival rate, had a lower frequency of administration and was easy. It is important to confirm that the eye-dropper to be used is made of virus-friendly plastic and that it be 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 (Figure 1). Always vaccinate birds in a shaded area.



**Figure 1.** Eye drop administration of the ND vaccine. When using an eye-dropper, hold it in a vertical position. Eye-droppers are calibrated according to the size of the drop that forms when the dropper is held in a vertical position.

#### *Age of bird*

The same dose is given to birds of all ages, from day 1 to adults.

#### *Vaccination schedule*

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

#### **Dilution and use of the vaccine**

The I-2 vaccine is 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, let the treated tap water stand overnight to allow the chlorine to dissipate.

Once the vaccine has been diluted, the following rules apply for eye drop administration:

- Day 1 ⇒ 1 drop per bird (i.e. first day of vaccination campaign);
- Day 2 ⇒ 2 drops per bird;
- Day 3 ⇒ discard.

#### **Horizontal spread of vaccine virus**

Laboratory trials in Australia, Mozambique and Vietnam demonstrated that the I-2 ND vaccine spreads from vaccinated to unvaccinated birds when housed together (Bensink and Spradbrow 1999; Tu et al. 1998). 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 birds.

#### **Safety issues**

The avirulent live ND vaccine I-2 is unusual in that it is not possible to overdose with it, given that it is completely innocuous to both bird and handler. It produces no evidence of clinical respiratory signs, weight loss, mortality in young chickens or egg production drop after vaccination (Bensink and Spradbrow 1999).

#### **Field results to date**

Field records indicate that the I-2 ND vaccine provides approximately 80% protection in the field in the face of an outbreak, when given every 4 months via eye drop. In one area where vaccination with the I-2 vaccine was performed at 4-monthly intervals with assistance from VetAID (a British NGO), the chicken population in 134 households increased from

an average of seven birds per family to 20 birds per family in a six-month period (Pangani 1999). During a five month field trial, where bird numbers were monitored on a two weekly basis, a 50% increase in bird numbers and increased home consumption was noted.

### Current production and sale prices

The production of ND vaccine in very low dose formats (i.e. lower than 250) suitable for use by individual village chicken farmers with few birds is relatively expensive. The vial, cap, rubber stopper and label are the most costly parts of freeze-dried vaccines. The vaccine itself is relatively inexpensive. For the foreseeable future, INIVE will offer the I-2 vaccine in 250, 500 and 1000 dose vials.

Generally, it is not too difficult to organise vaccination of 250 birds in a village if the vaccinator is suitably trained to promote the vaccination campaigns. Once a number of vaccination campaigns have been implemented and chicken numbers have increased, vaccinators sometimes decide to purchase vials of 500 doses. To date, the 1000 dose vial has not been requested.

The current sale price covers production costs and includes a small margin to cope with devaluation of the local currency (Table 1).

**Table 1.** Current sale prices according to number of doses of the I-2 ND vaccine produced at INIVE.

Vial size	Price/vial (MZM*)	Price/dose (USD)**
250 doses	20 000 MZM	US\$0.005
500 doses	25 000 MZM	US\$0.003
1000 doses	30 000 MZM	US\$0.002

\* Mozambican Metical.

\*\* Average exchange rate, March 2000: US\$1.00 = 14 900 MZM.

### Extension Material Produced to Accompany the I-2 Vaccine

The basic extension package took more than two years to develop and required considerable attention to detail. Revision of the package is under way currently with the assistance of a sociologist and feedback from field workers. Material in preparation includes a manual for trainers of community vaccinators and a simple checklist for community vaccinators.

All printed material has been produced in black and white to facilitate duplication by photocopiers at the provincial level and to minimise ongoing costs at the completion of the project.

One advantage of local production of the vaccine is that all the accompanying written material was prepared in Portuguese, the official language of the country. In the field, this information is translated into the appropriate local language(s). Most imported veterinary vaccines and medicines are accompanied by instructions in English making the information inaccessible to most Mozambicans.

The current extension package includes:

- **Radio programs.** A radio drama and a question and answer program in Portuguese and 4 local languages. These programs are broadcast together with the ND vaccination song on national and community radios. The text of the programs is included in the ND field manual to facilitate the local recording of programs in other local languages.
- **A ND vaccination song** prepared by the Mozambican Musicians Association after visiting one of the vaccine field trial sites. This song, with versions in Portuguese and 3 local languages, has been very well received in the field.
- **A pamphlet**, written in Portuguese, provides an introduction to ND and its control. It is printed on both sides of an A4 sheet and is easily reproduced. The pamphlet is useful for front line extension staff, literate farmers, farmers' associations and school children.
- **A poster** written in Portuguese with 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 venue, date, time and contact person for the next ND vaccination campaign.
- **A drama piece** written by a local theatre group with experience in community development after visiting one of the vaccine field trial sites. This piece runs for 20 minutes and covers most aspects of ND control including the need to vaccinate before chickens get sick and to pay for the vaccine. Drama in the form of role plays is also used during the training of extension workers and community vaccinators.
- **A ND field manual** written in Portuguese (Alders et al. 1999). The manual aims to inform senior veterinary field staff of the areas requiring attention when ND control campaigns are undertaken. Chapter headings include the importance of ND in village chickens, the characteristics of ND, the collection and submission of samples for the diagnosis of ND, the control of ND, an introduction to live, thermostable ND vaccines, gender aspects, ethnoveterinary knowledge and the development of an extension program for ND control.
- **A flip chart for use by front line extension staff** using clear, largely self-explanatory line drawings with an accompanying narrative in Portuguese.

Local frontline staff translate the Portuguese into the appropriate local language. For example, an illustration is used to demonstrate how to hold a bird and administer the vaccine via eye drop from an eye-dropper held in the vertical position (Figure 1).

### Conclusion

The development of a successful ND control program requires close collaboration between those involved in the production and testing of the ND vaccine, field veterinary and extension staff, and village chicken farmers. All involved must be willing to invest adequate time and resources to the development and evaluation of all aspects of the control campaign.

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# Mozambican Field Experience — Gaza Province

J.S.R. Langa<sup>1</sup>

## *Abstract*

This paper describes field experiences with the control of diseases in village chickens in Gaza Province. From 1994 onwards, several non-government organisations (NGOs) became involved in rural projects in Gaza Province, including vaccination campaigns to control disease, using mainly La Sota or Komarov vaccines and later thermostable Newcastle disease vaccines. The vaccination campaigns were carried out in the districts of Mabalane, Massingir, Chicualacuala, Guijá, Chókwé, Chibuto and Xai-Xai, through the NGOs and the Provincial Livestock Services (SPPs), using community livestock workers or community vaccinators.

GAZA PROVINCE is in southern Mozambique, 200 kilometres from Maputo. The province borders Kruger National Park, South Africa, in the southwest and west; Zimbabwe, and Manica and Inhambane Provinces in the north; and Inhambane Province and the Indian Ocean in the east. With a total area of almost 75 709 square kilometres (7 570 900 hectares), the province has 1 505 570 hectares used for cultivation, 3 407 225 hectares for forestry, and 2 008 580 hectares for livestock.

There are 11 districts in the province and the human population is around 1 118 542 (1997), with a projected population of 1 203 294 in the year 2000.

The climate is tropical with three different agro-ecological areas with very different rainfall: the coastal area receives 800 mm per year; the mid-Limpopo or central area approximately 400–600 mm; and the higher Limpopo or north area only 400 mm.

The people of Gaza Province keep ruminants such as cattle, as they are important in agriculture for animal traction as well as being a status symbol. The Provincial Veterinary Services dedicates more of its resources and makes more of an effort to provide assistance for cattle than it does for other animals, such as poultry.

## **Vaccination Campaigns**

Campaigns to vaccinate chickens started in 1994 and involved participants such as community livestock workers (CLWs) and community vaccinators, and was coordinated by the Provincial Livestock Services (SPPs). Before this, vaccination was carried out only by individual farmers using La Sota or Komarov vaccines. One of the objectives of the vaccination campaigns was to increase poultry production by reducing losses due to diseases, particularly Newcastle disease (ND), and improve food security in rural areas.

In 1994, a NGO, World Relief, began vaccinating chickens with La Sota vaccine. This campaign focused on the northern Province in the Districts of Guijá, Mabalane and Chicualacuala, and involved community participation. Unfortunately, details of the vaccinations carried out under this project are not available due to the floods that occurred in the Province.

From 1998 to 1999, another British NGO, VETAID, under an Institutional Support Project financed by the European Union, implemented a ND control program in Gaza Province. This included five vaccination campaigns, one every 4 months from May 1998, using thermostable vaccines, such as I-2 and NDV4-HR. The districts involved were Massingir and Mabalane in Gaza Province, and Panda in Inhambane Province.

In 1999, the Rehabilitation Project financed by the African Development Bank organised a vaccination

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campaign in two districts, Xai-Xai and Chibuto. This project used the inactivated ND vaccine Ita-New.

### Strategy

In order to ensure sustainability of vaccination campaigns against ND, it was decided to work through the network of village livestock community livestock workers. These CLWs have autonomy but are under the control of Livestock Services and are employed on a cost-recovery basis. The CLWs were trained to treat and prevent the principal diseases in chickens, including one-week-old chicks. This training was organised in March and May 1998. In total, 27 CLWs were trained in 6 districts (Massangena, Chicualacuala, Massingir, Mabalane, Guijá and Chókwe).

The vaccine used was NDV4-HR, which was chosen for the following reasons:

- cheapness;
- ease of use (by eye drop);
- ease of conservation (thermostable for 8 weeks at 28 C°); and
- safety (apathogenic strain).

NDV4-HR vaccine was replaced by I-2 vaccine, which has been produced in Mozambique by the National Veterinary Research Institute (INIVE) since 1999. The I-2 vaccine was substantially cheaper (250 doses for 20 000 MZM, 500 doses for 25 000 MZM and 1000 doses for 30 000 MZM) than other ND vaccines. A disadvantage is that, although the vaccine protection period is good, it does not last as long as inactivated vaccines (4 months rather than 6).

Before each vaccination campaign, meetings were organised with the CLWs at district level to discuss the organisation of the campaign (estimation of needs, providing information to farmers, practical organisation and payment). Unfortunately, after the first campaign, the 3 CLWs of Chicualacuala and Massangena were not invited, for economic and logistical reasons.

From the start, payment for the vaccinations was introduced in all areas. One thousand pamphlets about vaccination against ND and its cost were distributed through the CLWs to the farmers. At the beginning, the price of the vaccination covered only the labour of the CLW (200 MZM per chicken). The vaccine itself was initially provided free as it was still in an experimental phase. From August 1999, the farmers paid for the vaccine, at a cost of 100 MZM per chicken.

After the first two campaigns, it became clear that payment would be the main problem in increasing the number of chickens vaccinated. By the end of 1998, it was decided to concentrate on intensive training and extension work. ACIAR/INIVE

developed audiocassettes with songs and information in the local languages to inform farmers on ND and the advantages of vaccinating chickens. The material was duplicated and distributed to the villages. A copy was also given to the local radio, radio Xai-Xai.

Under the VETAID Project, training and extension material for the farmers was prepared, in Portuguese and Changane, for half-day training sessions. In March 1999, training in the villages started, conducted by the livestock officers in villages. The impact of the training has been difficult to measure, but the CLWs and livestock officers say that there has been a positive impact.

In August 1999, meetings were organised in the project districts with the CLWs and livestock officers in order to evaluate the activity and to identify a way for its continuation after the end of the project. The main decisions were that the project would facilitate the supply of the vaccine, and farmers would have to pay for the vaccine, as well as for the labour.

For large-scale vaccination to succeed, more farmers must become interested in vaccination of their chickens, and more vaccinators need to be involved. Because the vaccine is easy to use, vaccination can be done by farmers as well as CLWs.

For this reason, a new strategy was proposed. The livestock officers would organise meetings in the district to explain:

- the possibility of preventing ND with vaccinations;
- the frequency and cost of the vaccination; and
- that someone from the village could do the vaccination.

Two or three interested people were chosen for a half-day training in order to explain: how to handle the vaccine; how to dilute the vaccine; how to vaccinate a chicken; when to do the vaccination; and where to buy the vaccine.

To support this activity, the existing training/extension material for farmers was revised in September 1999, and a booklet was developed and then sent to the livestock officers for distribution.

### Difficulties with the Project

The major problem is the large human, organisational and financial resources required. This is particularly evident with the training and support of CLWs. Due to the low population density, a CLW can only cover an area containing around 2500 to 3500 inhabitants, the size of a big village.

A further problem is the shortage of SPP staff required to monitor the CLWs and also to follow up the activities after the end of the project.

The CLW does not always have sufficient education to enable good transmission of data. Even

though a CLW may have the confidence of the villagers, she/he does not always have all the educational and personal attributes that the project needs.

Payment is also a major constraint as farmers are not in the habit of paying for animal treatment, and place different priorities on the use of the little money they have. The districts where the scheme has been more successful are those ones where other NGOs, such as World Relief, have already worked on animal health projects, on a cost recovery basis.

The establishment of the support network for the CLWs and livestock officers was limited to certain areas or districts of the Province, and covered only 4 of the 11 districts.

To control ND, good vaccination cover is required, and chickens need to be vaccinated three times a year, which takes time and money.

### Results

In order to evaluate the vaccination campaigns, a monitoring system was developed. Each CLW received a vaccination register to report data on the vaccinations. The first register was too complex, and results were inaccurate. For the second vaccination campaign, a simplified sheet was distributed to evaluate the numbers of chickens vaccinated, and how much vaccine was used per bottle. This was important because CLWs were using bottles of 100 and 1000 doses, and it was not known how much vaccination they used in one day. The data revealed that the average number of vaccinations used per bottle was: for bottles of 1000 doses, 323 vaccinations (never higher than 400); and for the bottle of 100 doses, 85 vaccinations. We can therefore assume that a CLW can do about 300 vaccinations in one day.

In total, there have been five vaccination campaigns to date. Between 40 000 and 54 000 doses of vaccine were distributed for each campaign, at no charge for the first four campaigns. Under the VETAID Project, it is estimated that between 20 000 and 25 000 chickens were vaccinated using I-2

during the first four campaigns, but data are uncertain. Under the 1999 African Development Bank Project in two districts of Chibuto and Xai-Xai, 51 218 chickens were vaccinated with Ita-New, using extension workers from the Provincial Agricultural Extension Service (*Serviços Provincias de Extensão Rural*), CLWs, and extension workers from the Association for the Development of Rural Communities (*Associação para Desenvolvimento das Comunidades Rurais*), a local NGO in Xai-Xai.

### Impact on Production

Since the commencement of the vaccination programs, there has been an increase in chicken numbers. In the NDV4-HR/I-2 vaccination sites, the average flock size before vaccination was seven chickens and this increased to 20 chickens over a period of 6 months.

Before vaccination, 80% of flocks in the Province had fewer than 10 chickens. After 6 months, 53% of flocks had 11 to 30 chickens. The maximum flock size before vaccination was 29 chickens, which, following vaccination, had grown to 93 chickens after six months.

An interesting result, that while not quantifiable is promising, is the fact that since March 1999 in the district of Mabalane and Massingir, traders have been arriving regularly to buy chickens. They arrive by train in Mabalane and by road in Massingir. They also travel to quite isolated areas, such as Mavodze (140 km from Chókwé). The price of chickens in these areas is 20 000 to 25 000 MZM, depending on the size of the chickens, and in Xai-Xai or Maputo from 30 000 to 35 000 MZM. The reason seems to be that bush chickens are much more appreciated and can get a better price in town. Often the traders prefer to exchange goods for chickens, but there are still established rates. For example, in Mabalane a trader gives two little aluminium pans (3 litre capacity each) for 3 chickens.

# VETAID Field Experiences with Newcastle Disease Vaccinations in Mozambique

E.F. Dieleman<sup>1</sup>

## *Abstract*

This article describes VETAID's experiences with Newcastle disease (ND) control in four projects in three provinces of Mozambique between 1994 and 1999. Vaccination campaigns were conducted by either project staff and staff of provincial livestock services, community animal health workers or village vaccinators, with the lentogenic La Sota vaccine and with the thermostable ITA-NEW, NDV4-HR and I-2 vaccines. Vaccination numbers are high with efficient vaccine use (1.3 doses per bird) when project and provincial livestock staff organise and implement ND vaccination campaigns. However, this type of intervention is costly and not sustainable. A community animal health worker or village vaccinator can vaccinate up to 1000 chickens per day when farmers bring their birds to the vaccinator and 300 when the vaccinator visits farmer households. Farmer participation in ND control programs depends on the level of extension and awareness-raising, whether payment for vaccination is required and on available financial resources. With regular vaccination (three times per year), a definite increase in chicken numbers can be observed. Based on VETAID's experiences in different projects in Mozambique, it is concluded that ND control can only be sustainable when community members are trained in the application of locally produced thermostable vaccines, vaccines are available at district level and cost recovery is introduced from the start. Extension and awareness-raising must be part and parcel of any program.

VETAID is a United Kingdom (UK) based non-profit, non-governmental organisation (NGO) working for poverty reduction and food security of people dependent on livestock. VETAID has been working in Mozambique since 1993.

In Mozambique, chickens play an important role in traditional ceremonies, household food security and as a financial reserve for rural families. One of the major constraints to improving poultry production and productivity is Newcastle disease (ND), which decimates village flocks on a regular basis.

VETAID's experiences with ND control result from vaccination campaigns conducted in a Community Restocking Project implemented in four districts of Inhambane province (1993–1996); a Livestock Rehabilitation Project (1995–1997); a Livestock Support Project (1997–2000) in Mutarara district of Tete province; and on campaigns conducted in six districts in Gaza province and two in

Inhambane province, during a Stock Breeding Support Project (1996–1999).

Joint surveys between VETAID and the Serviços Provinciais de Pecuária (SPP, Provincial Livestock Services), showed that ND is endemic in all three provinces. As ND control was considered imperative in improving poultry production, information was collected to establish the most frequent outbreak periods; vaccination campaigns were implemented one month before possible outbreaks would occur.

To date 14 campaigns have been organised: five in Inhambane province (1994–1996), four in Tete province (1997–1999) and five in Gaza and Inhambane provinces (1998–1999).

## **Materials and Methods**

In the respective campaigns, the lentogenic La Sota vaccine (thermolabile; locally produced at the National Veterinary Research Institute, INIVE), first four campaigns in Inhambane and first campaign in Tete) and the thermostable vaccines ITA-NEW

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(inactivated, Laprovect Pty Ltd, last campaign in Inhambane), NDV4-HR (live, Avirulent, Cyanamid Pty Ltd, two campaigns in Tete and all campaigns in Gaza/Inhambane) and I-2 (live, Avirulent, locally produced at INIVE, last campaign in Tete) were used. The reason for substituting the La Sota vaccine, which provides five months protection, by vaccines that require revaccination after 4 months, were the difficulties encountered in maintaining a cold chain under district and field conditions.

Dose rates per vial were dependent on the type of vaccine. La Sota and ITA-NEW came in vials of 1000 doses, NDV4-HR in vials of 100 and 1000 doses. For the I-2 campaign, vials of 250 doses were purchased. The La Sota, NDV4-HR and I-2 vaccines were applied by the eye drop method, either with a 5 cc syringe or an eye-dropper, one drop per chicken. ITA-NEW was injected.

The number of campaigns varied from one to three per year and related to the type of vaccine, logistics and climatic conditions in the different areas. Vaccination brigades, consisting of VETAID and SPP staff, carried out the vaccination campaigns with the La Sota and ITA-NEW vaccines. Vaccinations with NDV4-HR and I-2 vaccines were conducted by community animal health workers (promoters) and/or community members trained as village vaccinators. Vaccinators recorded names of chicken owners and number of chickens vaccinated.

Vaccinations were mainly conducted at central locations within a village (one to five per village). However, in the Gaza/Inhambane (G/I) project, vaccinators would go from house to house to vaccinate. The length of the vaccination campaigns varied from one week to two months. Payments for vaccination were introduced from the start in the G/I project and during the last campaign in the Tete project.

Before the start of each campaign, village leaders and community members were informed about the coming campaigns through village visits and through posters, pamphlets, educational and extension material, produced in Portuguese and local languages by the respective projects and by ACIAR/INIVE. Where community radio was available, extension messages were broadcast on local radio.

## Results

### Community Restocking Project (Cunhete et al. 1996)

Vaccination campaigns in Inhambane province, during the Community Restocking Project, were conducted in Homoine, Maxixe, Inhambane and Jangamo districts. The number of vaccinated chickens increased from 10 821 in the first campaign

to 24 141 in the penultimate campaign (Table 1). However, there was a drop in the number of vaccinated chickens during the last campaign. As the number of participating families continued to increase from 2077 in the second campaign to 4546 (85.2% of the households) in the final campaign, this would indicate a reduction in number of chickens per household. No reasons were given for this reduction. Regular blood samples were taken and sent to INIVE for antibody testing. Acceptable levels of antibodies were found in 60% of the samples within the first two months after vaccination.

**Table 1.** Results of Newcastle disease vaccination campaigns in Inhambane province.

Campaigns	Numbers vaccinated	Number of families	Number of districts
Jul/Aug 1994	10 821	—	4
Dec/Jan 94/95	18 470	2 077	4
May/July 1995	17 791	1 538	3
Nov/Jan 95/96	24 141	2 487	3
May/Jun 1996	17 350	4 546	4

### Livestock Rehabilitation Project (Cunhete 1997) and Livestock Support Project (Boland and Tambo 1998; Dieleman, unpublished data)

To date four campaigns (May 1997 and 1998, and May and October 1999) have been conducted in the south of Mutarara district, Tete province. Data are presented in Table 2. In 1997, 16 villages, with five to six vaccination locations each, were incorporated in the campaign. In total, 18 260 chickens from 2312 households were vaccinated with 24 000 doses of vaccine. The number of households per village was not recorded. In 1998, through the training of village vaccinators, 37 villages could be covered. Each village had only one vaccination point. In total, 15 659 chickens belonging to 1404 households in 36 villages were vaccinated. One village did not participate, as the vaccinators were unable to open the bottle of vaccine. During this campaign, 35 000 doses of vaccine were distributed.

The first campaign in 1999 was organised in the same manner as the 1998 campaign. In this campaign, at least 10 618 chickens from 962 owners in 28 villages were vaccinated with 29 000 doses of vaccine. Reasons for the reduction in participating villages were twofold. In 1999, the NGO World Vision (WV) started with ND vaccinations in Mutarara district and the organisation agreed to take over five villages from VETAID, which were located in WV's operational area. The second was the result

**Table 2.** Results of vaccination campaigns in Mutarara district, Tete Province.

Village	May 1997			May 1998			May 1999			October 1999		
	Doses La Sota	Chickens vaccinated	Number of households	Doses ND V4-HR	Chickens vaccinated	Number of households	Doses V4-HR	Chickens vaccinated	Number of households	Doses I <sub>2</sub>	Chickens vaccinated	Number of households
Dzmira	—	—	—	—	—	—	—	519 <sup>a</sup>	21 <sup>a</sup>	750	3	3
Mpanducane	—	—	—	300	347	17	—	—	—	500	0	0
Canxixe	—	—	—	1 000	470	20	—	—	—	—	—	—
Sinjal	2 000	1 199	—	1 000	247	30	—	571 <sup>a</sup>	64 <sup>a</sup>	—	—	—
Muemba	—	—	—	1 000	413	39	—	—	—	—	—	—
Nsewa	—	—	—	1 000	297	41	1 000	196	15	500	0	0
Thoera	500	446	—	1 000	213	42	1 000	204	28	500	0	0
Puiti	1 500	1 369	—	1 000	943	101	1 000	334	49	500	0	0
César	—	—	—	1 000	115	25	1 000	206	26	500	0	0
Mbala	—	—	—	300	433	29	1 000	741	43	500	0	0
Muadindi	—	—	—	1 000	997	52	—	—	—	500	0	0
Chavundira	2 000	1 675	—	2 000	551	73	—	—	—	500	0	0
Muanda	2 000	1 982	—	2 000	1 377	89	—	—	—	500	0	0
Chinsomba	2 000	1 186	—	1 000	1 108	43	—	—	—	—	—	—
Mutarara Velha	—	—	—	1 000	909	81	—	—	—	1 250	123	18
Nh. Dona Ana	—	—	—	300	225	30	1 000	471	42	—	—	—
Nh. Aguiar	2 000	248	—	1 000	150	15	1 000	148	10	—	—	—
Sucamiala	1 000	840	—	1 000	418	47	1 000	551	40	—	—	—
Kanga	600	559	—	1 000	0	0	—	—	—	—	—	—
Traquino	400	266	—	1 000	277	20	1 000	417	21	500	557	33
Inhangoma	1 000	929	—	1 000	434	60	1 000	284	30	500	374	25
Nhasanha (Inhangoma)	—	—	—	—	—	—	1 000	162	17	500	265	20
Chilembwe	—	—	—	1 000	438	47	1 000	931	65	500	0	0
Nkassano	—	—	—	1 000	483	56	1 000	640	64	—	—	—
Jardim	—	—	—	1 000	519	51	1 000	439	43	500	0	0
Baué	1 000	944	—	1 000	260	29	1 000	43	7	250	0	0
Mpani	—	—	—	1 000	359	21	1 000	413	32	—	—	—
Charre	3 000	2 747	—	2 000	260	23	2 000	111	18	1 000	0	0
Manduwa	2 000	1 185	—	1 000	274	31	1 000	105	15	250	0	0
Culeche	1 000	669	—	1 000	159	25	1 000	362	44	1 000	564	61
Dovu	—	—	—	1 000	250	24	1 000	577	91	750	595	73
Minjale	—	—	—	300	372	45	1 000	766	58	1 000	*	*
Macuate	—	—	—	1 000	201	17	1 000	352	40	—	—	—
Calema	—	—	—	300	146	14	1 000	279	19	1 000	*	*
Nhanguirima	—	—	—	1 000	881	31	1 000	617	31	750	48	4
Vila Nova da Fronteira	2 000	2 016	—	1 000	281	34	1 000	247	43	750	21	6
Chicote	—	—	—	300	371	47	1 000	163	27	—	—	—
Mtemampini	—	—	—	1 000	255	25	1 000	*	*	500	*	*
Nharúguê	—	—	—	200	226	30	1 000	859	44	500	0	0
Totals	24 000	18 260	2312	35 000	3 142	292	29 000	859	1 047	16 750	0	0

— no vaccination \* still awaiting data .

of a conflict between VETAID and village vaccinators concerning payment for two days' labour (half-day training/refresher course and one-day vaccination). The belated last campaign, October 1999, was the first one in which payment (100 MZM per chicken) was introduced. This, combined with the absence of some vaccinators due to land preparation and a ND outbreak before the start of the campaign, had a negative influence on the number of chickens vaccinated. To date, some data still need to be retrieved. Therefore, it can only be reported that at least 2550 chickens from 243 owners in nine villages have been vaccinated. In total, 16 750 doses of vaccine were distributed to 27 villages.

To assess the impact of ND control, revaccination by farmers was recorded. Twenty-four villages could be partially compared. Table 3 presents the number of participating chicken owners per campaign per village from 1998 onwards and the number of revaccinations per village by the same owners. In May 1999, 256 farmers in 22 villages revaccinated their chickens. In October 1999, 11 farmers in four villages, who had been vaccinating in 1998 and did not vaccinate in May, vaccinated their chickens again. Forty-four chicken owners in five villages

vaccinated twice in 1999 and only 14 farmers in 3 villages vaccinated their chickens in all three campaigns. These three villages have a promoter.

#### Stock Breeding Support Project (Pagani 1999)

In the G/I project 5 campaigns were organised in 1998–1999 at 4-month intervals. Vaccinations took place in the districts of Massing, Chicualacuala, Massingir, Mabalane, Guija and Chokwe in Gaza province and in the districts of Panda and Homoine in Inhambane province. The vaccinations were conducted by promoters. From the start, payment was introduced. Initially, only the labour cost for the promoter (200 MZM per chicken, US\$0.015) was charged, but since August 1999, the cost of vaccine (100 MZM) has been part of the farmer's contribution as well.

Exact data on vaccination numbers are not available. It is estimated that in the first four campaigns, 20 000 to 25 000 chickens were vaccinated per campaign. Before the start of each campaign, 40 000 to 54 000 doses of the NDV4-HR vaccine were distributed. The average number of doses used per vial was 323 for vials of 1000 doses, with a maximum of 400 doses, and 85 doses for vials of 100 doses.

**Table 3.** Revaccination by chicken owners per village per campaign.

Village	1998	1999(1)	1999(2)	1998/ 1999(1)	1998/ 1999(2)	1999(1)/ 1999(2)	1998/1999(1)/ 1999(2)
Baué	29	7	0	3			
Calema	14	19	*	10			
César	25	26	0	10			
Charre	23	18	0	4			
Chicote	47	27	—	13			
Chilembwe	47	65	0	1			
Culeche	25	44	61	8	4	13	6
Dovu	24	91	73	0		23	
Inhangoma	60	30	25	7	2		2
Macuate	17	40	—	5			
Manduwa	31	15	0	15			
Mbala	29	43	0	20			
Minjale	45	58	*	23	*	*	*
Mpani	21	32	—	8			
Nhamayabue D. Ana	30	42	—	9			
Nhanguirima	31	31	4	25			
Nharúguè	30	44	0	26			
Nhasanha	—	17	20	0		5	
Nkassano	56	64	—	30			
Nsewa	41	15	0	3			
Puiti	101	49	0	15			
Sucamiala	47	40	—	12			
Traquino	20	21	33	1	3	2	6
Vila Nova da Fronteira	34	43	6*	8	2	1	
Totals	827	881	222	256	11	44	14

— no vaccination; \* still awaiting data.

To assess the impact of ND vaccination campaigns, the numbers of chickens per household of 215 farmers were recorded during the second campaign (Oct–Nov 1998) and of 134 farmers during the fourth campaign (April–May 1999). Data were collected in the same operational areas of selected promoters. It is not clear whether 134 households were visited both times. In November 1998, 80% of the households possessed less than 10 chickens. The maximum number of birds per household was 29. In May 1999, 53% of the monitored households possessed 11 to 30 birds. The maximum number recorded was 93 birds. Another indication of an increase in chicken numbers, which is attributed to ND control, is the fact that from March 1999 traders started coming to Mabalane and Massingir districts to buy or barter chickens.

### **Vaccines**

When comparing the different vaccines, the following advantages and disadvantages are observed.

The lentogenic La Sota vaccine has the advantage that it gives protection against ND for five months. However, the fact that a well-maintained cold chain is required and that it can cause reactions in the vaccinator, plus the size of the vials (1000 doses), make it less suitable for use under village conditions.

With respect to the thermostable NDV4-HR and I-2 vaccines, it is reported that these vaccines maintain their activity for 3 months at 28°C, which is an asset for village vaccination by farmers. These vaccines have the additional advantages that (i) they can be administered via the ocular route, nasal route or via drinking water, (ii) they spread through contact when birds are housed together, (iii) they are avirulent and can therefore be used in chickens of all ages, from day one onwards, and (iv) they are safe to use. A minor disadvantage is the relatively short protection period of four months. This problem could be overcome by using ITA-NEW, which has a five-month protection period. However, it only maintains its activity for two to four days at ambient temperatures of 15–25°C and must be injected, either intramuscularly or subcutaneously, which makes it less suitable for farmer administration. Other disadvantages related to the NDV4-HR and ITA-NEW vaccines are that both vaccines are commercial and as such must be imported.

### **Number of campaigns per year**

In all projects, at least two campaigns per year were planned, although attempts were made to vaccinate three times a year with the NDV4-HR and I-2 vaccines. In Tete, this could not be achieved due to

the transition of projects in 1997 and the lack of NDV4-HR vaccine within the country in the third quarter of 1998. When the vaccine arrived, the rainy season had started and road conditions became such that a campaign could not be organised.

### **Vaccine use**

In comparing the different implementation modes of ND control, the most efficient use of vaccine (1.3 doses/chicken) is when vaccination is conducted by trained brigades with continuous logistical support (Cunhete 1997). However, this is a very costly intervention, which is not sustainable. The 1997 campaign cost US\$2000 or US\$0.11 per chicken. With today's exchange rate, this would be 1650 MZM. To put this into perspective, egg prices vary from 500–1000 MZM at district level; chickens are sold for 15 000–25 000 MZM.

With vaccinations conducted by promoters or village vaccinators, a difference can be observed between vaccination at a central village location and vaccination at household level. When farmers bring their chickens to the vaccinator, more than one thousand chickens can be vaccinated in one day, while a promoter in G/I can vaccinate a maximum of 300 chickens per day by travelling from house to house.

One problem for either type of vaccination is vials of 1000 doses. A vaccinator travelling from house to house uses on average 323 doses (G/I). In Tete, vaccinators are strongly advised against transporting diluted vaccine from one place to another, due to lack of cool boxes and the high ambient temperatures in the province. When vaccine can only be used in one place and a village consists of several small localities, which are rather spread out, then a lot of vaccine is wasted. For this reason, vials of 250 doses of the I-2 vaccine were purchased in the last campaign. This enabled vaccinators to vaccinate at different locations and vaccination could be spread over several days, if required.

### **Sustainability**

The sustainability of ND control remains to be seen. Campaigns organised and implemented by VETAID and the SPP have not proven to be sustainable, as shown by the Community Stock Breeding Project in Inhambane. When VETAID left, ND vaccinations ceased to take place.

With farmer vaccination, sustainability stands or falls according to the extension services provided, awareness raising of the population, availability of vaccine (if not at village level then at least at district level) and on the financial means of the population.

A well-established distribution chain would be a great asset in this respect. In the G/I project, revolving funds for drugs and vaccines have been established in those villages where a trained promoter is present. Stocks of I-2 vaccine have been set up at the SPP offices in Xai-Xai, Chokwe, Mabalane and Massingir in Gaza province, and in Maxixe and Panda in Inhambane province, and also in a private pharmacy in Chokwe. To date it is not clear what will happen when these stocks run out. However, the relative proximity to Maputo may guarantee continued availability of vaccine in those districts.

In Tete, extension has not been an important part of the ND control programs. From the impact assessment, it can be concluded that farmers do not yet have confidence in ND vaccination. The fortunate occurrence that there was no ND outbreak in the second half of 1998 may have created the impression that it does not make any difference if one vaccinates or not. Although participating families are increasing in certain villages, most participants are new ones. One reason for the increase in October 1999 may have been the ND outbreak before the campaign. Villagers might have tried to save their animals by vaccination. To date no provision has been made to guarantee availability of vaccine after August 2000. It remains to be seen if the SPP can fill the gap that VETAID will leave behind.

### Conclusions

In relation to the advantages and disadvantages of the different vaccines and VETAID's experiences with ND control in different provinces, it can be concluded that the non-injectable thermostable vaccines have clear advantages in the Mozambican context under village conditions.

Even at district level, it is difficult to maintain a cold chain, since refrigerators, either gas, petroleum, solar or electric, are not common items at agricultural and/or livestock offices. With the availability of thermostable vaccines, villagers can be trained to vaccinate their own chickens as well as those of their neighbours' chickens. This would not only reduce costs for the livestock services, but would also enable farmers to vaccinate their chickens at a day and time of their choice. A minor disadvantage of the live thermostable vaccines is the shorter protection period, which requires more frequent vaccination.

However, the additional cost due to the increased frequency of vaccination does not outweigh the advantages.

In comparing the different thermostable vaccines available in Mozambique (ITA-NEW, NDV4-HR and I-2), I-2 appears to be the vaccine of choice. It can be applied by eye drop or via drinking water, it is produced locally (no importation problems), not commercialised (relatively cheap), and comes in easily manageable vials of 250, 500 and 1000 doses.

It should be noted that ND control can only be sustainable if timely cost recovery is introduced, preferably from the start, as is done in the G/I project, and vaccine is available locally. Then by the time a project or program finishes, farmers have experienced the advantages of ND vaccinations and are used to paying for such interventions. Awareness-raising through extension plays a crucial role in the success of a program.

When farmers have been accustomed to hand outs and receiving everything free, as was the case in the Tete projects, they are less likely to appreciate the value of an intervention. Where people are used to paying for veterinary services, vaccination numbers tend to increase. This was observed in Mabalane district of Gaza province, where the NGO World Relief had been working in animal health on a cost recovery basis, and in some villages in Mutarara district, where promoters charge villagers for treatments.

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# Village Chicken Production in Vietnam and Newcastle Disease Control with Thermostable Vaccine

Tran Dinh Tu<sup>1</sup>

## Abstract

Village or garden chickens are important items in the economy of Vietnamese villages. Newcastle disease is the major constraint to improved production. Conventional Newcastle disease vaccines are used successfully in Vietnam to protect commercial chickens. Their use in villages is limited because of their heat sensitivity. The I-2 strain of thermostable Newcastle disease vaccine is now made in Vietnam. Initial laboratory and pilot village trials indicated the suitability of this vaccine for village use. The present report describes field trials that indicate the efficacy of I-2 vaccine when given by eye drop or on cooked white rice and the thermostability of the vaccine. I-2 vaccine was superior to La Sota vaccine for village use because of its ready spread by contact. Large-scale trials indicated a considerable drop in the incidence of Newcastle disease in villages that used I-2 vaccine. Navetco intends to produce 10 million doses of the vaccine for village use in 2000.

VIETNAM is a tropical country in Southeast Asia, S-shaped and stretching 2000 km from north to south. The area of 329 566 square km supports a population of 78 million of whom 80% live from agriculture. Agriculture accounts for 30% of the GDP and is based mainly on rice production, followed by other crops such as maize, sweet potato, cassava, groundnuts, soya beans and sugar cane. There are also fruit trees and other perennial trees like coffee, rubber, tea and coconut.

Livestock production, mainly buffalo, cattle, pigs and poultry contributes 25% of the agricultural output. Animals and poultry form an integral part of village life and have important social functions in Vietnam. They are an important source of income for village families and provide a cheap source of protein for rural people.

## Village Chicken Production

The poultry population of Vietnam increased during the past decade (Table 1). Chickens are raised in every village in Vietnam, and 75% of the national flock is kept under traditional village conditions. Villagers use free-range, backyard or semi-intensive

systems but not intensive systems. Most farmers keep chickens, but the smaller flocks contain only a few birds. Other poultry such as ducks (including Muscovies) and geese are also kept in villages.

**Table 1.** Poultry population and production in Vietnam<sup>a</sup>.

Year	Chickens (millions)	Ducks (millions)	Meat production (thousand tonnes)	Egg production (millions)
1993	95	31	170	2300
1994	101	32	186	2600
1995	108	34	197	2800
1996	115	38	230	—

<sup>a</sup> Source. National Extension Service Department, 1997.

Chicken meat made up 16% of the total meat production in Vietnam in 1996. Chicken production per capita (3.5 kg of meat and 46 eggs in 1996) is anticipated to reach 6.6 kg of meat and 63 eggs in 2000.

During the past three decades, the Vietnamese government has encouraged the industrialisation of poultry production. Exotic breeds of broilers (Plymouth, Hybro, Cobb, Hubbard, Ann Arbor) and layers (Leghorn, Hubbard, Comet, Moravia, Goldline-54, ISA-brown, Brown Nick) were imported.

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Industrial production required not only exotic breeds, but access to concentrates, vaccines and excellent management. The dense industrial populations of chickens encourage the transmission of infectious diseases. Some of these were exotic diseases that spread to local flocks. The intensive industry with its high costs had to compete with chickens produced in villages at lower cost.

Local chicken meat is perceived to be more tasty and of higher quality than that of many exotic breeds. This has led to an increased demand for 'garden chickens' in Vietnam. Consumer judgement of quality, and the effect on market price, is indicated in Table 2.

**Table 2.** Ranking of quality, price and market potential of some broiler breeds in Vietnam.

Breed (origin)	Quality	Price	Market potential
NAGOYA (Japan)	Very good	Highest	Local and export
RI (Vietnam)	Good	Medium	Local and export
TA VANG (Vietnam)	Good	Medium	Local and export
TAMHOANG (China)	Good	Medium	Local
SASSO (France)	Fair	Medium	Local
AA (USA)	Poor	Lowest	Local

There is a diversity of local breeds raised for different purposes. The most popular local breeds are Ri, raised in the North, and Ta Vang or Tau Vang in the South. These are dual-purpose breeds, slow growing but adapted to local feeds and the hot climate. They have high resistance to diseases and parasites. Other well-known breeds for meat production (Dong Cao, Dong Tao and Mia) previously raised in North Vietnam are now becoming rare. Consumers prefer some breeds because of the yellow colour of feathers and skin, features that are favoured for the frequent spiritual festivals held in Vietnam and for family offerings. Some breeds are raised for specific purposes: Choi and Tre breeds for village cockfights; and Ac for making traditional tonics to benefit people who are old or sick.

Although village chicken production has increased in response to consumer preference for local birds, there remain major constraints. The productivity of village chickens is low and needs to be improved. Limited production has led to a high price for the product. Most are sold live and consumed locally. In remote areas, there are no good facilities for slaughtering and processing. Infectious disease and parasitism cause substantial losses and disease control is difficult in unconfined chickens.

## Newcastle Disease and its Control

Newcastle disease (ND) has probably been present for a long time in Vietnamese chickens. However, the first official confirmation of the disease by laboratory diagnosis was not until 1949. Since then, ND has been considered as the major fatal disease of chickens in Vietnam. Outbreaks are frequently reported in village chickens but until recently there were few firm data on incidence, morbidity, mortality and nature of the causative virus. There are few scientific reports on ND in the Vietnamese literature, and these are mostly concerned with single surveys. ND is still endemic throughout Vietnam and is especially significant in remote areas where disease control is rarely practised by villagers. Provincial veterinary services recognise that ND occurs throughout the year, peaking in the period November to March. ND is apparently the highest cause of loss in village chickens, and even farmers with good management skills agree that, unless ND is effectively controlled, all efforts to increase chicken production will be wasted.

A survey conducted in An Giang province by Mai Hoang Viet (1988) showed that the incidence of ND in village chickens varied from 6.7% to 38.6%, apparently depending on the knowledge and experience of the individual farmer in applying preventive vaccination. The mortality in affected chickens varied from 69.1% to 88.6%. Losses were greater in chickens less than 7 months of age. Mortality was many times higher in freely scavenging village chickens than in confined village chickens, as the latter were more readily vaccinated. During his survey, 36 isolates of ND virus (NDV) were isolated from 134 samples from sick chickens. Isolations were made in embryonated eggs and the presence of NDV confirmed by haemagglutination and haemagglutination inhibition tests. Diagnostic laboratories frequently reported the viscerotropic velogenic form of ND in chickens presented for autopsy.

The characters of some Vietnamese isolates of NDV established at Navetco are shown in Table 3.

**Table 3.** Pathogenicity indices of some Vietnamese isolates of Newcastle disease virus.

Virus designation	MDT <sup>a</sup>	ICPI <sup>b</sup>	IVPI <sup>c</sup>	ELD <sub>50</sub> <sup>d</sup>	LD <sub>50</sub> <sup>e</sup>
VN 91	57	1.77	2.67	9.4	7.8
AK	38-48	—	—	8.0	7.8
Navetco virulent	<50	—	—	7.5	6.1

<sup>a</sup> Mean embryo death time in hours.

<sup>b</sup> Intracerebral pathogenicity index.

<sup>c</sup> Intravenous pathogenicity index.

<sup>d</sup> 50% embryo lethal dose per mL of allantoic fluid.

<sup>e</sup> 50% chicken lethal dose per mL of allantoic fluid.

Methods to control ND commenced as early as the 1960s, and are based mainly on vaccinations of a lentogenic vaccine given at an interval of three weeks followed by a booster with mesogenic vaccine 4 to 6 months later. This program is effective and controls ND on commercial farms and in villages if applied routinely. In remote areas, most farmers do not use the vaccines. This is due partly to lack of knowledge and partly to the lack of vaccines suitable for use in scavenging chickens.

At present, all the poultry vaccines produced in Vietnam are freeze-dried live vaccines. The first ND vaccine used in Vietnam was the Asplin F vaccine. This vaccine and fowlpox vaccine were introduced from the Weybridge Institute, UK, in 1956. F strain was followed by the Mukteswar strain (from China in 1964) and La Sota strain from the former Soviet Union in 1968. Recently, a new thermostable ND vaccine has been developed. The vaccine has evolved from a V4-like strain designated I-2 provided to Navetco by Professor P. Spradbrow of The University of Queensland, Brisbane, Australia. This vaccine has been highly appreciated by the farmers and rural development officers because of its preventive efficacy and ease of use. In 1999, nearly 8 million doses of the thermostable vaccine were produced and sold from Navetco. It is expected that 10 million doses will be required in 2000 to meet increasing demand.

### **Production of I-2 Vaccine**

The procedure for producing vaccines at Navetco is relatively simple. Before 1995, the vaccine seeds were passaged serially in commercial eggs, without a proper seed-lot system. However, Navetco always seeks to produce safer and more effective vaccines. After the receipt of the seed stock of I-2 vaccine from Professor Spradbrow in 1994, vaccine production was changed to a seed-lot system. For I-2 vaccine, sound eggs from a commercial farm were used to produce master seed-lot (MSL) and then the working seed-lot (WSL) from which vaccine was produced. Both MSL and WSL were subjected to sterility and potency tests and then stored at  $-70^{\circ}\text{C}$ .

Vaccine is produced in clean, fertile eggs from commercial sources. Ten-day-old embryonated eggs are candled and cleaned with 0.5% iodine solution. Through a hole drilled in the shell, the allantoic cavity is inoculated with 10 000 EID<sub>50</sub> of virus. The diluent is phosphate buffered saline containing 100 IU penicillin and 100Ug streptomycin per mL. The inoculation site is sealed with paraffin wax and the eggs incubated at 37°C. The eggs are candled daily and any with dead embryos are discarded. The infected allantoic fluid is harvested after incubation

for 96 hours and overnight chilling at 4°C. Allantoic fluid is collected into 1000 mL bottles. Each is tested for sterility before pooling and titration to allow calculation of a field dose of vaccine. The required titre is 10<sup>7</sup> EID<sub>50</sub> per bird dose. The vaccine is mixed with 10% skim milk powder, dispensed and freeze-dried in vials containing 25, 50 or 100 doses.

Samples of vaccine undergo quality control tests before the vaccine is sold. Sterility tests are undertaken in duplicate in aerobic nutrient broth, anaerobic nutrient broth, blood agar plates and Sabouraud agar for fungi. In vivo tests are made for safety and potency. Ten susceptible chickens less than 10 days of age are each given 10 field doses by eye drop. There must be no observable reaction over the next 10 days, in comparison with 10 control chickens. The potency test uses 10 3-week-old commercial chickens each receiving a single field dose by eye drop. Three weeks later, the vaccinated chickens and 5 control chickens are challenged by intramuscular injection of 10 000 LD<sub>50</sub> of virulent NDV. The test is valid if 80% or more of the vaccinated chickens survive and 80% or more of the control chickens die over the next 2 weeks.

The resulting vaccine is very cheap. The price of a dose is 60 VND (US\$0.005). The small number of doses in each vial is suitable for small village flocks. Even the poorest farmers in Vietnam can now afford the vaccine to protect their backyard chickens.

### **Field Trials and Technology Transfer**

Earlier laboratory and pilot village field trials have already been described (Tu et al. 1998).

The purpose of further field trials was to establish the efficacy of the new vaccine under field conditions and to demonstrate efficient vaccination strategies to the village farmers. Two postgraduate and five undergraduate veterinary students wishing to do their MSc or DVM degree theses were recruited to assist. Three provinces, Ho Chi Minh City, Dong Thap and An Giang, were used for the trials. Provincial staff who were to assist were trained to recognise ND and in various aspects of vaccination. At a later stage, discussions were held in villages to explain ND and vaccination to farmers whose flocks would be used in the trials. Flocks containing 50 to 200 suitable chickens were selected. More than 600 farmers living in 52 villages in 18 districts participated.

Three major trials were undertaken. Basic methodologies were common to the trials. Vaccine was administered to chickens at 3 weeks of age, when about 10% of the birds were bled to establish base line serology. A second vaccine was given two weeks later. Chickens were bled to determine antibody



responses and at the end of the experiment, chickens were purchased for challenge with virulent NDV. Non-vaccinated chickens from other villages served as controls.

The first trial examined in replicate routes of vaccination (eye drop, drinking water and feeding on cooked white rice). The results are shown in Table 4. Eye drop vaccination gave the best results, but vaccination with feed was the most convenient for uncontrolled scavenging chickens.

The second trial tested freeze-dried vaccine that had been kept at room temperature for 1, 2 or 3 weeks. The results are shown in Table 5. The vaccine was stable at room temperature for at least 3 weeks.

The third trial allowed a comparison of I-2 and La Sota vaccines as shown in Table 6. I-2 was the preferred vaccine because of its capacity for horizontal transmission.

A fourth trial was for demonstration and extension purposes. During 1996–1997, 300 000 doses of I-2 vaccine were distributed free to farmers in the three provinces. Efficacy of vaccinations was evaluated by monitoring the incidence of ND before vaccination and 6 months after vaccination. The results for 10 villages in Dong Thap province are shown in Table 7. In all 10 villages, the incidence of ND was lower after vaccination. The I-2 vaccine was effective in chickens that were also receiving fowl cholera vaccine.

**Table 4.** Efficacy of I-2 vaccine applied twice by various routes to village flocks.

Route	Province	Before vaccination <sup>a</sup>		Two months after vaccination		
		HI antibody <sup>a</sup>	HI antibody <sup>a</sup>	% = 3 <sup>b</sup>	Survived/challenged	
Eye drop	Dong Thap	1.6	4.5	88.4	9/9	
Eye drop	HCM City	1.2	5.1	96.0	10/10	
Feed	Dong Thap	2.2	4.4	78.2	10/10	
Feed	An Giang	1.1	2.4	56.8	ND <sup>c</sup>	
Water	An Giang	1.1	2.5	45.6	ND	
Water	HCM City	1.1	3.2	74.8	9/10	
None	Dong Thap	—	2.0	0	1/10	
None	HCM City	—	2.0	0	0/5	

<sup>a</sup> Geometric mean titre, log<sub>2</sub>.

<sup>b</sup> Presumed protective titre.

<sup>c</sup> Not done.

**Table 5.** Response to I-2 vaccine stored for various periods at room temperature in Dong Thap province.

Storage time (weeks)	Number of chickens	Before vaccination		Two months after		
		HI <sup>a</sup>	One month after HI <sup>a</sup>	HI <sup>a</sup>	Survived/challenged	
1	162	0.6	5.1	4.1	11/12	
2	128	1.0	4.1	4.3	12/13	
3	204	0.6	5.8	4.9	11/12	
No vaccine	12	—	—	1.9	1/12	

<sup>a</sup> Geometric mean titre, log<sub>2</sub>.

**Table 6.** Comparison of efficacy of I-2 vaccine and La Sota vaccine under village conditions in An Giang province.

Vaccine	Route	Number of chickens	Before vaccination		Two months after vaccination		
			HI antibody <sup>a</sup>	HI antibody <sup>a</sup>	% = 3 <sup>b</sup>	Survived/challenged	
La Sota	Eye drop	129	0.5	4.5	88	19/20	
La Sota	In contact	29	0.3	0	0	3/20	
I-2	Eye drop	152	0.8	3.4	70	19/20	
I-2	In contact	38	0.4	3.5	72	20/20	
None	—	5	—	0	0	0/5	

<sup>a</sup> Geometric mean titre, log<sub>2</sub>.

<sup>b</sup> Presumed protective titre.

**Table 7.** Efficacy of I-2 vaccination campaign in Dong Thap province.

District	Incidence of Newcastle disease in flocks	
	Before vaccination	6 months after vaccination
Hong Ngu	65.0	17.1
Tan Hong	60.0	18.0
Tam Nong	50.0	20.0
Thanh Binh	40.0	5.8
Thap Muoi	80.0	30.4
Than Hung	86.0	7.1
Lai Vung	85.0	11.0
Chou Than	65.0	11.5
Sa Dec Town	35.0	9.2
Cao Lanh Town	70.0	23.3

### Conclusion

Village chicken production will only advance if there is effective disease control practised by farmers. The control of ND will require suitable vaccines and appropriate technology. Experience in Vietnam indicates that I-2 is a suitable vaccine that can be produced locally and at a price that allows full cost

recovery. I-2 vaccine is preferred for village use in Vietnam. Its advantages over the other ND vaccines produced in Vietnam are thermostability and ability to spread between chickens. Even remote areas lacking refrigerated transport can be reached by the vaccine and farmers can be taught the simple methods of application.

### Acknowledgments

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# The International Cooperation Centre in Agronomic Research for Development (CIRAD)

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## Abstract

This paper outlines the structure and mission of CIRAD, focusing on activities in the Department of Animal Production and Veterinary Medicine (EMVT) related to control of Newcastle disease (ND). In Senegal, ND causes losses of 60% to 90% of birds in small-scale poultry systems (estimated population 12 million chickens) especially between the months of February and May. Both live (HB1, La Sota, Clone 30) and inactivated (Imopest, Ita New, Newcavac Nobilis, Pestaviform) vaccines are available. To date on small-scale farms, inactivated oil adjuvant vaccine has been preferred as the other ND vaccines are only available in large dose format and require a cold chain. The I-2 ND vaccine is to be produced at ISRA-LNERV. The CIRAD program in Zimbabwe is working with the Department of Veterinary Services and the EU to find solutions to the problem of ND.

THE International Cooperation Centre in Agronomic Research for Development (CIRAD) is a French scientific organisation specialising in agricultural research for development for the tropics and subtropics. It is a State-owned body, which was established in 1984 following the consolidation of French agricultural, veterinary, forestry, and food technology research organisations for the tropics and subtropics.

CIRAD's mission is to contribute to the economic development of these regions through research, experiments, training and dissemination of scientific and technical information. The Centre employs 1800 persons, including 900 senior staff, who work in more than 50 countries. Its budget amounts to approximately French francs 1 billion, more than half of which is derived from public funds.

CIRAD is organised into seven departments: CIRAD-CA (annual crops), CIRAD-CP (tree crops), CIRAD-FLHOR (fruit and horticultural crops), CIRAD-EMVT (animal production and veterinary medicine), CIRAD-Forêt (forestry), CIRAD-TERA

(land, environment and people), and CIRAD-AMIS (advanced methods for innovation in science). CIRAD operates through its own research centres, national agricultural research systems and development projects.

CIRAD EMVT has three main programs:

- The rangeland and wildlife management program focuses on sustainable management of natural resources used by domestic or wild animals, and on ways to conserve animal biodiversity.
- The animal production program is concerned with the production systems, their improvement and economic aspects, and modelling of the systems.
- The animal health program develops diagnostic tools and methods for controlling major tropical diseases.

The Fight against Newcastle Disease in Senegal

Senegal has a population of 9 million people of whom 40% live in rural areas. About 70% of rural people keep chickens.

Bird rearing has developed considerably in the past few years, particularly in the sector of intensive poultry farming. The region of Dakar has most of this activity within a radius of 100 km around the capital. Traditional poultry farming is also carried out in all regions, with an estimated 10 to 12 million head of poultry.

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Such a concentration of animals explains the rapid spread of diseases. In the country, there is one animal disease which regularly brings disaster by causing high mortalities and loss of production — Newcastle disease (ND) or pseudo-fowl pest. This virus is the most contagious of bird diseases and is responsible for an average mortality rate of 60% to 90% on affected farms. Epidemics decimated the poultry population in 1995, especially in the intensive farming sector. The application of suitable vaccine protocols has now reduced the occurrence of the disease, both in broiler and layer production. But the reduction or even permanent elimination of this disease is only possible if the poultry population is properly vaccinated.

### **Distribution of production systems**

Modern farms, broiler and layer commercial enterprises extend around Dakar as far as Thiès and Mbour. Traditional farms are spread throughout the country. Raising poultry is a secondary activity for the farmer; and this task is most often passed on to the women and children. Chickens are an important source of income (real supplementary income), and are socially significant because of their use in family celebrations.

### **Sensitivity of chicken breeds**

All breeds are sensitive to ND, with the clinical expression depending on the pathogenicity of the virus concerned. There are in fact non-virulent viral strains, lentogens causing few signs, mesogens causing respiratory signs and velogens responsible for high mortality.

### **Economic impact**

In modern farms, ND is no longer the main cause of mortality because of efficient vaccination regimes.

On traditional farms, it is much more difficult to quantify precisely the losses caused by ND in the 12 million chickens, but different reports regularly indicate epidemics that destroy the poultry population of entire villages, in particular between February and May. According to the farmers, this disease affects non-vaccinated poultry and young birds, with mortality in the region of 60% to 90% of unprotected birds. This represents a significant economic loss, mainly in meat production, since egg production is generally very poor.

### **Vaccines**

Two types of vaccine are available on the market, live vaccines and inactivated vaccines.

#### *Live vaccines:*

- HB1 (ISRA-LNERV, Poulvac HB1, Hitchner Vaccine Nobilis);
- La Sota (Sotasec, Poulvac la Sota, la Sota vaccine Nobilis);
- Clone 30 (Clone 30 vaccine Nobilis);
- I-2 thermo-tolerant being prepared with ISRA-LNERV.

#### *Inactivated vaccines:*

- with aluminium sulphate adjuvant: Pestaviform (ISRA-LNERV);
- with oil adjuvant: Imopest (Rhône-Mérieux);
- Ita New (Laprovect);
- Newcavac Nobilis (Intervet).

Live vaccines are in common use due to the simplicity of their use. The vaccine provides rapid protection, but immunity only lasts a short time. These live vaccines should be used to vaccinate young birds, and are necessary to improve the effectiveness of inactivated vaccines administered to older poultry. Protection conferred to the flock by live vaccines is less homogeneous and lower and less long lasting than that conferred by inactivated vaccines administered by injection. These injectable vaccines are essential to protect layers and sometimes broilers.

Vaccination of traditional poultry has had to be carried out using inactivated oil emulsion-based vaccines since live vaccines are too fragile (except in the case of the I-2 strain). Inactivated oil emulsion-based vaccines are reputed to be more stable at room temperature, but the cold chain should be respected to the maximum, even with traditional methods.

The choice of vaccine should also be cost-effective and take into account the existence of vials containing 100 doses (rather than 500 or 1000 doses) in order to be able to adapt to variable sizes of farms.

### **Eradication program**

An extensive program of medical prophylaxis was implemented in the commercial farms with the vaccination done by private veterinarians.

In traditional farms, an inactivated oil emulsion-based vaccine was used in small quantities (100 doses), at the end of winter (November) and the beginning of the hot dry season (March). The first vaccination occurred at 1 month (feathered chicks) with an injection of a half dose of inactivated oil emulsion-based vaccine and then every 6 months with an injection of one full dose. Every new bird, no matter what period it is introduced, is required to be vaccinated. On traditional farms, private veterinarians and Ministry of Agriculture officials have to be called in to supervise the operation.

Vaccination, however effective, can only work properly if accompanied by prevention measures (health prophylaxis) that either prevent the introduction of the virus into a ND-free area, or avoid its spread by other sources once it appears. At the national level, this means putting in place legislation aimed at regulating animal imports (health certificate). An official hygiene and health control system (COSH in France) should be put in place for vaccination programs. Laboratory analysis of the disease and control of vaccination campaigns should be

established. There should be regulations, which stipulate what to do in case of appearance of the disease in an area.

#### **CIRAD EMVT Fight Against Newcastle Disease in Zimbabwe**

Since 1999, CIRAD EMVT has been working with the Veterinary Services (Dr S. Hargreaves) and the European Community (Mr Maline) to develop strategies for the control ND in Zimbabwe.

# Methods for Assessing the Impact of Infectious Diseases of Livestock — Their Role in Improving the Control of Newcastle Disease in Southern Africa

J. McDermott, P. Coleman and T. Randolph<sup>1</sup>

## *Abstract*

A framework for the impact assessment of disease control strategies for Newcastle disease (ND) is discussed. This includes linking epidemiological and economic data to predict the relative impact of different control interventions at different levels from farm to region. Epidemiological transmission models assume that village poultry are the reservoir of ND virus for other sectors. Simple models for transmission of the virus among village chickens predict that for vaccination to be effective, it must be conducted relatively frequently with a large proportion of chickens covered. Extrapolations to transmission between village and commercial sectors are suggested. Economic issues at farm level are considered most influential. Decisions to invest in national and regional projects will depend on the assessment of social equity impacts and cost-benefit and institutional analyses to assess relative benefits of private versus public sector interventions. Capturing the perspectives of all stakeholders in the ND control intervention process is considered crucial to both enhanced impact and sustainability of any control program.

THE contributions of poultry to the economy of African countries and the livelihoods of its people are profound. FAO (FAOSTAT 2000) estimates that there are approximately 1.1 billion chickens in Africa. Sonaiya et al. (1999) have estimated that for most countries, in excess of 70% of total poultry production is from the village (family) sector and this sector provides a frequently unaccounted for economic asset of approximately US\$ 5.75 billion. Crucially, in development terms, the village poultry sector preferentially benefits the rural poor and women (Sonaiya et al. 1999). Village chickens play several important social roles and a variety of poultry husbandry and ethnoveterinary practices have developed in many areas of Africa (Gueye 1999; Ibrahim and Abdu 1996). Many contributions to these Proceedings will highlight the crucial role of poultry to rural livelihoods in southern Africa.

While the village poultry sector in Africa has evolved to be robust and sustainable, infectious diseases, particularly Newcastle disease (ND), are an

important and sometimes catastrophic constraint (Alders and Spradbrow 1999, for several individual references). Vaccination against ND is a technically feasible (Biswas et al. 1996; Fontanilla et al. 1994; Samuel and Spradbrow 1991; Tantaswasdi et al. 1992; Wambura et al. 2000) but an economically non-sustainable control strategy for village chickens in Africa (Sonaiya et al. 1999). A variety of options to reduce control costs are being explored, including production of vaccine by developing country institutes (Spradbrow and Copland 1996; Wambura et al. 2000).

The difficulties encountered in the control of ND in Africa and elsewhere in the developing world highlight the importance of considering both veterinary and socio-economic aspects in designing ND control programs. At the International Livestock Research Institute, we have used ex-ante impact assessment methods, combining both epidemiological and economic tools, in supporting decisions for the control of other infectious diseases of livestock (Mukhebi et al. 1999; Perry et al. 1999).

In this paper, we propose a preliminary conceptual framework for considering technical and socio-economic factors at different levels influencing the

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impact of control strategies for ND. We then discuss key methods to support the assessment of impact of ND control. These include a mathematical model for the transmission of ND in the village poultry system and how this model could be extended to look at transmission from village to commercial sectors. The other main category of methods considered is economic. We discuss the main economic issues associated with the control of ND for different stakeholders. As a conclusion, we propose ideas for how impact assessment methods for ND control can be further developed to support decision-making.

### **A Framework for Assessing the Impact of Control Programs for Infectious Diseases**

Currently, most assessments of the impacts of alternative decision control options depend on extrapolation from individual case studies. Unfortunately, experiences may be quite location or production system specific and thus unsuitable for widespread generalisation. The development of more general frameworks for assessing the impact of infectious diseases can serve multiple essential purposes. These include:

- providing a structure for arranging and revising key questions;
- highlighting linkages (causal or otherwise) between technical and socio-economic issues at different levels;
- helping to identify important information and knowledge gaps; and
- emphasising the roles and responsibilities of different stakeholders.

There is often considerable overlap between the key issues for different infectious diseases. In developing a preliminary framework for ND in Southern Africa (Figure 1) we have started by modifying a framework developed for Foot and Mouth Disease control in Thailand (Perry et al. 1999). In the ND control framework, we have tried to highlight the much greater productivity effects of ND for individual farmers in village systems.

The purpose of developing frameworks to investigate the impact of alternative disease control strategies is to help support better decisions. All conceptual frameworks will be wrong; what we hope for is something useful in improving our decision-making. The utility of impact assessment can be enhanced by a number of key elements. The first, as mentioned, is the participation of different stakeholders and key players in formulating questions and providing data and their individual 'analytical' perspectives. This is essential since control programs for infectious diseases are doomed to failure without the effective collaboration of different stakeholders. A conceptual

framework of the impact of disease control may even help to clarify the organisational and coordination requirements for control efforts.

A second key element is a good understanding of how important epidemiological and socio-economic factors influence disease control. As will be emphasised throughout this paper, considering both types of factors is essential. Data requirements to enhance our understanding are described in later sections of this paper. In improving ND control, the different mix of epidemiological and economic factors involved in choosing between alternative strategies is complex. Only a tiny fraction of potential combinations could ever be tested under field situations. Thus, models, either mathematical models of infectious disease transmission and/or economic models incorporating different socio-economic perspectives, are increasingly used as decision support tools (see Anderson and May 1990 for numerous examples of how infectious disease transmission models have usefully supported a wide variety of public health decisions). From model results, best-bet strategies can be developed and tested in the field, usually in an iterative process.

### **Preliminary Application to the Assessment of Newcastle Disease Control in Southern Africa**

#### **Basic epidemiological model**

The main purpose of the epidemiological model for ND is to link demographic information for different poultry sectors to disease transmission parameters in order to assess the impact, on disease occurrence, of alternative control options. Our initial 'naive' approach is to structure the model as outlined in Figure 2.

The central feature of this structure is the transmission of ND virus (NDV) in village chickens under a non-endemic situation. The very simple assumptions for the village transmission model are listed in Table 1 and input parameters in Table 2. The current model considers only susceptible, latent, infectious and vaccinated classes of chickens. Recovered chickens (Alders and Spradbrow 1999) are ignored. The primary route of infection for commercial poultry is assumed (either directly or indirectly) to be from village chickens. Different commercial sectors could have different probabilities of infection.

The main use of this preliminary model is to highlight the need for frequent and high proportion coverage required in village vaccination programs under epidemic situations (Figure 3). The vaccination frequency and coverage estimates presented

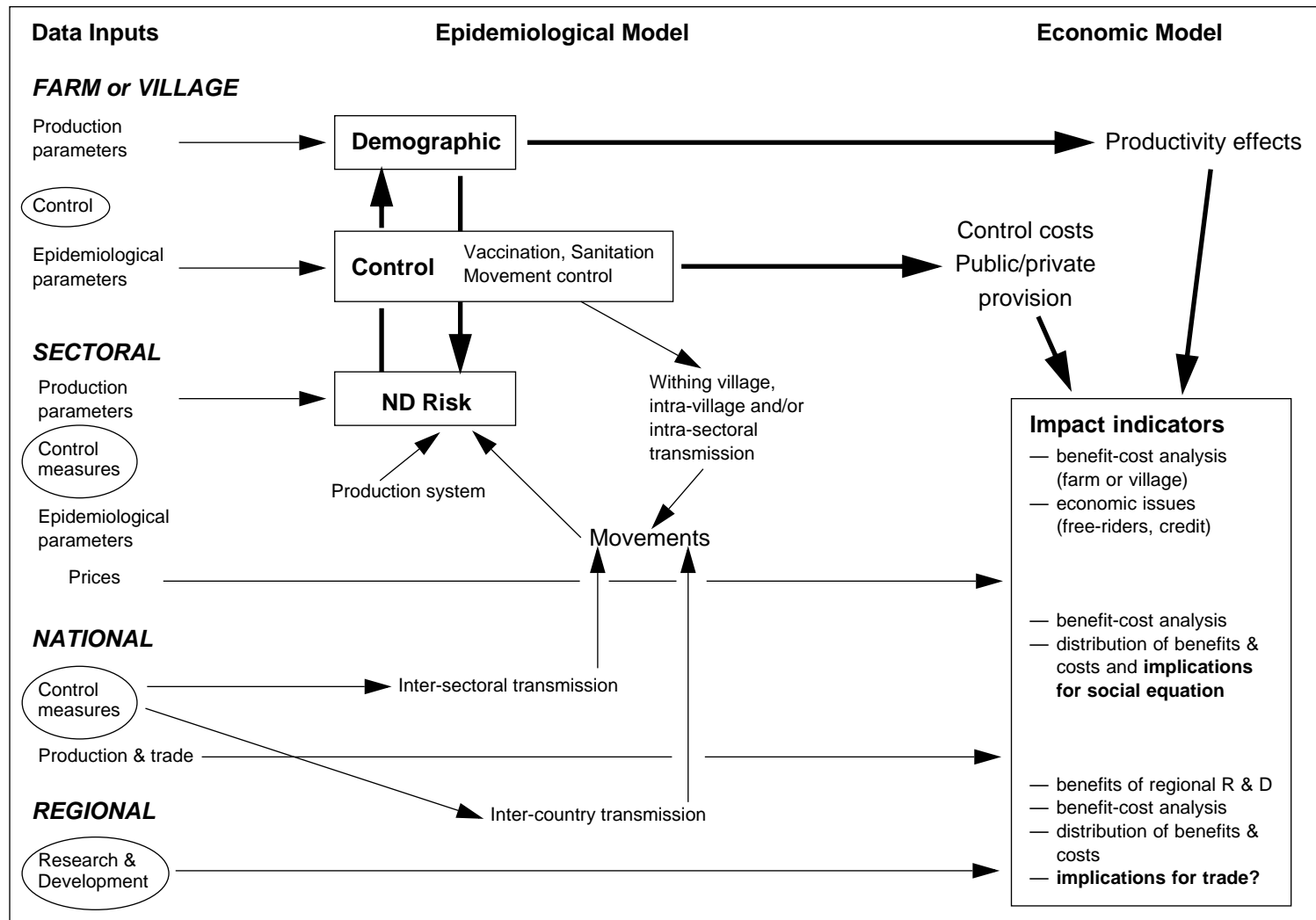
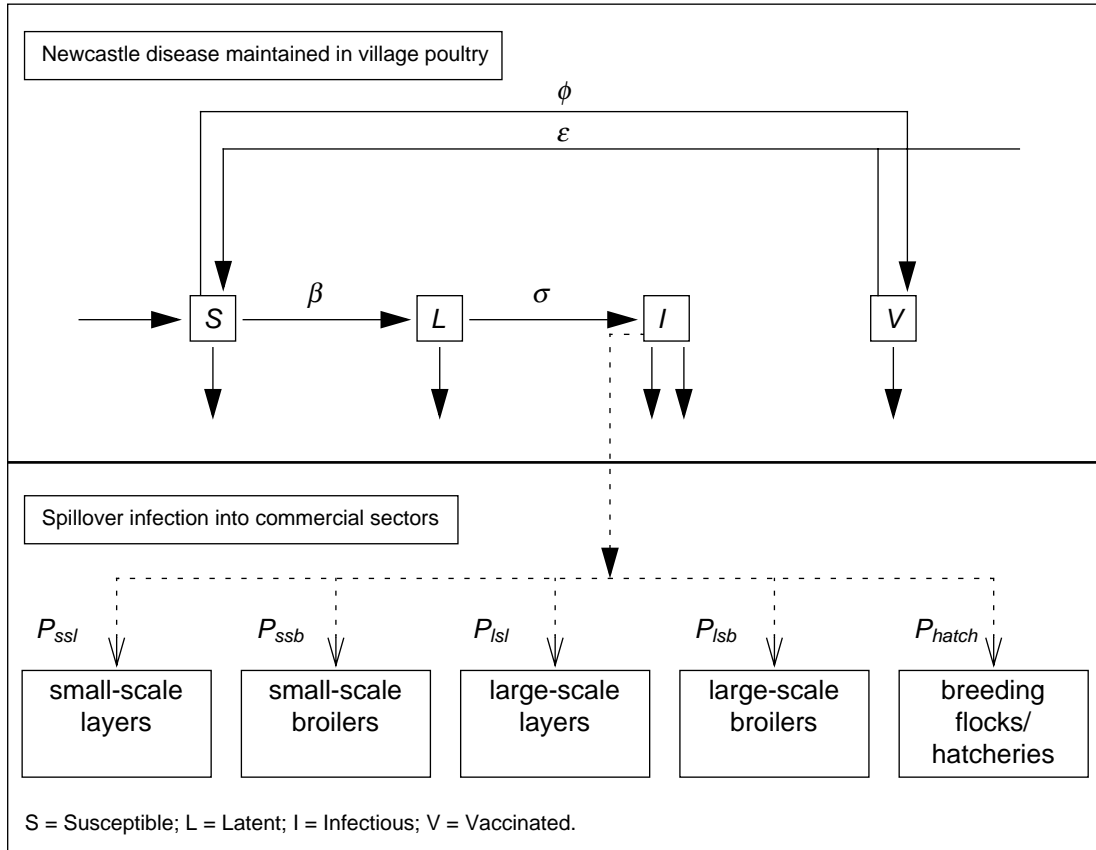


Figure 1. Example of a conceptual framework for the impact assessment of Newcastle disease control.





**Figure 2.** Model structure for Newcastle disease in village poultry.

**Table 1.** Model assumptions of an initial ‘naive’ model of Newcastle disease virus transmission in village chickens.

1. NDV persists in village poultry populations (Bell and Mouloudi 1988).
2. Most village poultry populations are large enough to maintain NDV without external introduction due to the high basic reproductive rate of NDV.
3. The village poultry population is assumed to be a single free-mixing host population. Spatial heterogeneity ignored at smaller (local) scale, could be introduced at larger (national and regional) scales.
4. Village poultry are an important source of infection to small and large-size commercial poultry farms. Transmission between commercial farms is much less important (Bell and Mouloudi 1988; Sen et al. 1998).
5. The probability of NDV infections in these sectors is proportional to the incidence in the village poultry sector.

**Table 1. Cont.** Model assumptions of an initial ‘naive’ model of Newcastle disease virus transmission in village chickens.

6. The probability of a ND outbreak in small and large-size commercial poultry operations is different but once an outbreak occurs all susceptible poultry will be affected.
7. Village poultry form a single, homogeneous, free-mixing population.
8. There are four epidemiological classes, susceptible, incubating, infectious and vaccinated.
9. All rates are exponential and constant with age and sex.
10. There is no recovery from ND.
11. Each vaccination round is conducted in a single day, with a proportion  $\nu$  of the population vaccinated.
12. The model is simulated on a daily time scale for a one-year period.
13. The disease can be introduced into the population at any time over the course of the year.

should be considered as only relative rather than absolute values and may even be incorrect by some order of magnitude, since our initial assumptions and structure have ignored a number of potentially key features (see below).

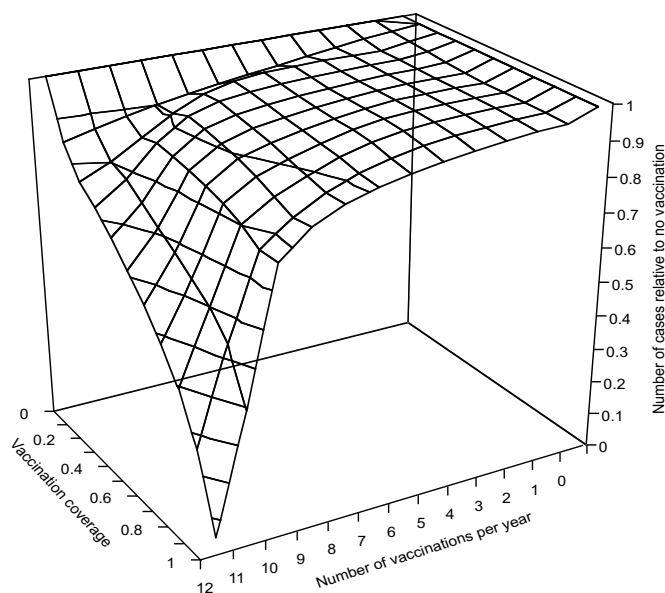
To make this model more useful, not only for the transmission of ND in village chickens but also for its spread between village and different commercial sectors, additional work is required. Currently, the model ignores the possibility of recovered chickens. This is likely to be important in village situations, particularly after the disease becomes endemic. Ignoring this possibility causes the model to predict ND outbreaks that are shorter and more severe than

would be expected under field situations. Empirical data on the proportion of chickens surviving ND would make this initial model more realistic and useful. Empirical field data on natural ND occurrence and its changes after the application of control measures is also crucial to uncover failures in model assumptions.

At present, we have not extended the model to consider the spread of ND to (and perhaps between) and impact in commercial sectors (Akhtar and Zahid 1995). Demographic data for each sector and empirical field data on outbreaks in each sector with temporal data linking them to outbreaks in village poultry and other sectors are required.

**Table 2.** Parameter estimates used in the initial Newcastle Disease village chicken model simulation.

Parameter	Symbol	Estimate	Source
Life expectancy	$1/\delta$	2 years	
Exponential growth rate	$R$	0.05 per year	
Initial population size	$N$	50 000	
Carrying capacity	$K$	100 000	
Latent period	$1/\sigma$	5 days	Merck Manual 1986
Infectious period	$1/\alpha$	4.5 days	Wambura et al. 2000; Fontanilla et al. 1994
Duration of immunity	$1/i$	126 days	Rehmani 1996
Vaccination coverage	$V$	varies, 0–1	
Vaccinations per year	$F$	varies, 0–12	



**Figure 3.** Example of a conceptual framework for the impact assessment of Newcastle disease control.

Epidemiological models provide a powerful tool for understanding how disease incidence is likely to evolve under different control strategies. This knowledge alone, however, is insufficient for making decisions on whether to implement a given control strategy. These decisions require additional information about the costs and benefits associated with control strategies to determine their economic viability and the likelihood that they can be successfully implemented.

### **Economic analysis of Newcastle disease and its control**

A common strategy for assessing the economic impact of infectious disease control is to perform a cost-benefit analysis of a specified control or eradication project for the use of investors and stakeholders in that project. Incorporating outputs from epidemiological models provides considerable relevancy and decision-making power to this approach (see as an example Perry et al. 1999). However, expanding this focus to address many of the economic issues likely to be important to different stakeholders implicated in the conceptual framework presented in Figure 1 will be necessary. Economic questions of interest will range from the poultry keeper's decision to protect his/her chickens from ND by vaccination, to decisions by an NGO or a government agency to introduce and promote the use of vaccines, through to the level of priority accorded to development of appropriately designed vaccine technologies by regional research systems. A range of techniques will be required, from traditional financial analyses of projects through institutional analyses (Leonard et al. 1999; Sandiford and Rossmiller 1997) to welfare analysis and other methods addressing key social equity concerns (see McDermott et al. 1999 for a range of economic issues applied to smallholder livestock systems).

#### *Issues and analytical approaches*

As indicated in Figure 1, decisions regarding ND depend on the scale and perspective of the decision-maker, varying from the individual farmers up to the policy makers and investors at regional level. Accordingly, decision-making at the various levels addresses different types of questions. Table 3 offers examples of typical questions that are likely to be relevant at each level, as well as the methodologies for economic analysis that are often found useful. In most cases, some type of standard cost-benefit analysis will likely be appropriate, either in the form of a partial budgeting approach that considers the impact of the disease or its control during a single production cycle, or a multi-period project analysis when evaluating a longer-term

intervention. In the latter case, the epidemiological model becomes critical in accurately predicting how disease incidence will evolve over time under each control scenario. Otherwise, as is often done, future disease incidence may be estimated based simply on the analyst's best guess, e.g. Sen et al. (1998).

In the context of ND in sub-Saharan Africa, three types of economic analysis are likely to be pertinent, at least initially, among those listed in Table 3:

- (1) farm-level partial budget analysis in the village sector;
- (2) national or regional-level welfare analysis of improved control in the village sector; and
- (3) analysis of delivery pathways for inputs and services.

Of these, the first two would require incorporating an epidemiological component to accurately capture the impact of control.

Emphasis on these three approaches is based on the underlying assumption that controlling ND with a vaccine is primarily a private good in the sense that the benefits of using a vaccine are captured primarily, and often solely, by the individual producer. In the context of endemic ND, using vaccine on an individual farm, or even intensively in a given region, will only have a significant impact on the risk of disease faced by other producers in the same or another sector if it is regularly and repeatedly used by nearly all farmers in that region. Thus, the possibility of non-vaccinators gaining 'free-rider' benefits is relatively unlikely.

Since nearly all benefits are captured at farm level, this is the appropriate level at which to analyse the economic feasibility of control. The widespread use of ND vaccines in commercial poultry production units suggests that economic incentives for their use are already well established and recognised. For commercial systems, economic analysis would concentrate mainly on choosing the optimal control strategy for maximising firm profits. For backyard systems, in which diseconomies of scale, low market orientation, and information asymmetries are likely to be associated with high transaction costs for disease control, the issues are more likely to focus instead on constraints to adoption and use of vaccines. The attention given to improving the effectiveness and efficiency of delivery pathways for vaccines is particularly relevant if these high transaction costs are to be reduced.

Under the current ND situation in Africa, vaccination is predominately a private good. Lack of immediate national and regional direct benefits may hamper support for large-scale publicly financed disease control campaigns. However, if there are to be both other compelling arguments and other types of investments (e.g. support to research on improved

**Table 3:** Economic issues and approaches at each decision-making level.

Level of analysis	Issues	Approaches
Farm/enterprise	<ul style="list-style-type: none"> <li>• Will the control strategy be adopted as indicated by its financial feasibility (i.e., profitability)? (Or related, which strategy optimises returns to investment in control?)</li> </ul>	<ul style="list-style-type: none"> <li>• Partial budgeting and/or gross margin analysis*</li> <li>• Farm models (linear programming, simulation)*</li> </ul>
Sectoral/production system	<ul style="list-style-type: none"> <li>• Will the necessary inputs and services be available to producers through effective, sustainable delivery systems?</li> <li>• Are there spillover benefits in one production system due to improved control in another (esp. reduced risk of outbreaks in commercial sector due to improved control in village sector) that might justify intersectoral transfers or subsidization?</li> <li>• Are production system-specific interventions economically justified?</li> </ul>	<ul style="list-style-type: none"> <li>• Market and institutional analyses</li> <li>• Farm-level analysis incorporating spillovers*</li> <li>• Project cost-benefit analysis of public interventions*</li> </ul>
National/regional	<ul style="list-style-type: none"> <li>• Are national or regional-level interventions economically justified?</li> <li>• What are the equity impacts of control? (producer versus consumer gains; gains captured by the poor versus higher-income groups)</li> <li>• Are there spillover benefits at the national or regional level, especially with respect to: <ul style="list-style-type: none"> <li>— reduced risk across production systems</li> <li>— less need for movement controls</li> <li>— enhanced trade opportunities?</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Project cost-benefit analysis of public interventions*</li> <li>• Welfare analysis (economic surplus analysis) taking into account market effects*</li> <li>• Trade analysis, including institutional/regulatory aspects*</li> </ul>

\*Using information generated by epidemiological modelling.

technologies and extension campaigns to introduce and promote vaccine use or to improve the efficiency and effectiveness of delivery pathways targeting subsistence-oriented village systems) that may be appropriate and necessitate economic evaluation. Such investments should also be supported by compelling non-financial objectives such as improving incomes, food security, or social equity. In this case, in addition to the farm-level analysis, it would be appropriate to conduct a welfare analysis that would take into account the eventual impact of reduced production costs on market supply and prices, to assess both the capacity of the intervention to generate sufficient social economic benefits and to what degree the benefits would accrue to producers versus consumers, or to the poor relative to the well-to-do. Such issues can be addressed by aggregating the results of the farm-level analysis to a higher level, and incorporating supply and demand considerations using an economic surplus approach.

Finally, improved disease control may reduce barriers to cross-border movements of poultry and poultry products, and thereby improve opportunities for trade. In the current context, trade opportunities are limited. In the future, though, analysis of such opportunities as an additional benefit or cost of better controlling ND may become increasingly relevant.

#### *Economic data requirements*

The various types of economic analysis outlined above generally require similar types of data. Most are related to valuing the incremental costs and benefits of each control strategy considered. The categories described below are certainly not exhaustive.

#### *Direct production losses avoided and their value*

The principal direct production loss associated with ND is mortality. Valuing these losses avoided at farm level under a given control intervention requires first identifying the representative age structure of losses by production system, and then assigning the appropriate market price or future value of production foregone for chickens at each age.

#### *Indirect production losses*

An outbreak of ND may engender additional financial costs that need to be enumerated. These include the opportunity cost of idle production capacity and any extra sanitary measures undertaken.

#### *Control costs*

These will primarily concern the cost of procuring and applying the vaccine, but may also include

interest on working capital tied up in control inputs at farm level, as well as any intervention project costs incurred.

#### *Household economic system*

To evaluate the potential for individual poultry keepers to adopt a given control strategy, it may be necessary to collect additional information about the role that poultry play in the household economy and the degree of market orientation of its poultry activities.

#### *Sector-level information*

To aggregate costs and benefits at the sector level, numbers of poultry kept under each production system are required, together with information about length of production cycle.

#### *Poultry market information*

For welfare analysis of a control strategy, it will be necessary to have market-level data on supply and demand for poultry and poultry products (including price elasticities), and prices.

### **Future Initiatives**

In this paper, we have tried to initiate consideration of the impact assessment of ND control using a combination of epidemiological and socio-economic methods. We have argued that a comprehensive view of control efforts needs to be made beyond individual case studies. We recommend that an overall decision-making framework be developed to include the 'perspectives' of all stakeholders. As non-experts of ND, our initial efforts are imperfect. Hopefully, experts and stakeholders in the region will take up the challenge to collaborate with us to improve this. As a first step, the epidemiological and economic analyses presented need to be improved by incorporating existing empirical data from the region and developing further studies to address key information gaps. This effort can benefit from the inputs of all stakeholders. International institutes such as the International Livestock Research Institute (ILRI) can play a supportive role to assist farmers, NGOs and governmental organisations in this important task.

### **Acknowledgments**

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# A Program to Improve Family Poultry Production in Africa

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## *Abstract*

The Joint FAO/IAEA Division of the International Atomic Energy Agency has initiated a coordinated research program (CRP) to improve family poultry production in Africa. The program assists 12 scientists working in National Agricultural Research Systems (NARS) during a period of five years with research in the subject. Regular research coordination meetings bring together all participants involved in the program to exchange results and experiences and to adjust work plans and protocols. Initially, a standardised survey was used to assess the characteristics of family poultry production in 24 different farms in two ecological zones in each country during the wet and dry seasons. Analysis of the survey will clarify the major constraints affecting family poultry production. Interventions will be initiated ranging from vaccination and other disease preventive measures to supplementary feeding, simple housing structures and improving marketing opportunities. The Joint FAO/IAEA Division has a successful history in managing and organising similar programs: in the distribution of the necessary equipment, kits and reagents; in the use of serological monitoring for epidemiological and disease control activities; and in the wider dissemination of results from such field studies in the form of guidelines and manuals.

WITH the exception of urban areas in northern and southern Africa, most poultry production in Africa is undertaken through an extensive system at village or family level. Almost every village household keeps domestic fowl (on average between 5 and 20 birds) and it is estimated that village fowl make up more than 80% of the total fowl population in Africa estimated at 1068 million in 1995 (Guèye 1998).

Under these circumstances, poultry provides a good source of protein and ready cash for villagers, which in turn helps to sustain the village economy and contributes to the prevention of urban migration. The benefits from family poultry production go directly to the rural poor, in most cases to the women who are the principal caretakers.

### **Constraints to Increasing Family Poultry Production**

Family poultry production suffers from the constraints of disease, particularly Newcastle disease,

insufficient feeding and lack of housing. Together, these factors result in a low level of productivity for this traditional system. If these constraints could be removed, productivity would increase, to the direct benefit of the marginal farmer. The immediate objective of a five-year research project is to develop strategies to overcome production constraints through a coordinated research program (CRP) involving 12 African investigators in collaboration with the Joint FAO/IAEA Division and with assistance from international experts in the subject.

In order to increase production, the importance of each factor needs to be investigated in the different countries in a coordinated fashion and, subsequently addressed by designing a package of disease prevention, improved housing and strategic supplementary feeding protocols. This goal can best be achieved through a close collaboration of international organisations, universities with an expertise in poultry management, and the National Agricultural Research Systems (NARS) in Africa.

### *Disease*

One of the constraints for increasing poultry production is poor health. Newcastle disease (ND) is regarded as the principal factor limiting rural poultry

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production in Africa (Awan et al. 1994). ND can typically kill up to 80% of household poultry in Africa (Spradbrow 1993–94). The survivors have high antibody levels and are resistant for a while, but as the level of antibodies and the level of protection fall, the population becomes susceptible again, and the cycle is repeated. The disease is spread by contact between birds, which is exacerbated by the practice of taking birds to market from a flock where disease is incubating. However, many aspects of the epidemiology of the disease in the village situation have not been fully understood (Awan et al. 1994).

Another important disease, especially for small-scale intensive broiler flocks, is Gumboro or Infectious Bursal Disease (IBD). This can kill up to half the chickens in a susceptible flock. IBD also has an immuno-suppressive effect, resulting in a poor response to vaccination and increased susceptibility towards other pathogens. Much less is known about the importance of IBD in African village chickens compared to ND, but in the few countries from which reports are available, the sero-prevalence seems to be high (Bell et al. 1990).

Intestinal and ecto-parasites are also of importance in traditional poultry production and can cause high mortality (Permin 1997).

Other pathogens that have been shown to be present in family poultry include *Salmonella* (Bouzoubaa et al. 1992), *Mycoplasma*, infectious laryngotracheitis, chicken anaemia agent, *E. coli* and fowl pox virus. Very little is known about the effects of these pathogens on poultry populations in rural Africa.

#### *Housing*

Other constraints to increasing poultry production in rural areas are losses due to predators and insufficient feeding. In some African countries, a large proportion of village poultry are lost due to nocturnal predators (Bell and Abdou 1995). In other countries, simple night shelters are constructed from locally available materials. Attention will be given to the possibility of providing overnight shelter to family poultry. This will involve assessment of the availability and cost of local building materials as well as an assessment of the benefits of overnight protection (resulting in a lower mortality).

#### *Feeding*

Family poultry survive by scavenging and generally, no feed supplements are provided. However, sometimes, household waste is fed to the birds and under other circumstances, the diet is supplemented with grains. If losses due to disease and predators are removed, it is very likely that the feed resource base

will become the major factor limiting production increase. Small amounts of strategically administered supplements are likely to increase production and minimise mortality once the other constraints have been removed. Various locally available food supplements can be tested for their effect on production levels (Gunaratne et al. 1993). Supplementation protocols will vary according to production system, ecological zone and the availability and cost of food-stuffs.

The interaction of the three constraints, disease, housing and feeding, underlines the necessity for an holistic approach to interventions. However, other constraints to poultry production should also be considered, such as marketing increased numbers of locally produced poultry products. A cost-benefit analysis should also form part of the activities to assess the economic advantage of the proposed interventions to the small farmer.

### **Activities of the Joint FAO/IAEA Division**

Various interventions are being developed, validated and transferred to the counterparts through an FAO/IAEA coordinated research program (CRP). A unique feature of the CRP is that a similar approach to technology development can be applied in a concerted manner to a large number of poultry production systems in a number of different countries. Another feature is that a modest amount of funds (US\$5000–8000 per year per person) allows scientists in developing countries to initiate applied research within their own environment. Experts in the subject matter have been selected as research agreement holders (RAHs) in order to assist the program with scientific advice, to solve specific scientific problems (as beneficiaries of technical contracts) and adjust the program to achieve its objectives (Table 1). The project is managed in the field through research coordination meetings (RCMs), bringing together all participants in the program to exchange results and experiences and to adjust work plans and protocols. The first meeting established the various protocols and delineated the activities and responsibilities of the participants.

Meetings will be held in the second and third year to discuss results and modify protocols as required. A final meeting will be held in the fifth year to produce conclusions and recommendations for sustainable implementation on a national scale.

The Joint FAO/IAEA Division has a successful history in managing and organising similar programs, in the distribution of the necessary equipment, kits and reagents, in the use of serological monitoring for epidemiological and disease control activities and in the wider dissemination of results



from such field studies in the form of guidelines and manuals. Advice is sought from collaborating partners concerning the integration of gender issues, a cost-benefit analysis and the sustainability of interventions (Table 2).

The aim of the program is to assist in the development and transfer of an integrated package to improve rural poultry production in a number of selected African countries. The applied research will ensure that vaccination protocols, improved feeding systems and husbandry adjustments are developed and applied in a manner which is most appropriate for each poultry production system. In addition, actions should be taken to ensure sustainability in health and management improvements of rural poultry production as a result of project interventions.

### First research coordination meeting

Each research contract holder (RCH as listed in Table 3) outlined the present situation and characteristics of family poultry production in the country of origin (Figure 1) during the first RCM in Rabat, Morocco. In addition, various aspects of family poultry production, and techniques for disease prevention and serological monitoring of immune status were presented.

The only practical way to tackle the viral diseases, ND and IBD, is by vaccination. The objective of vaccination is to establish a flock with a high immunity to prevent disease and the spread of virus (Spradbrow 1987). Four types of vaccine can be used for ND: conventional live vaccines, heat-resistant

**Table 1.** Research agreement holders.

Country	Institute	Name of RAH*
Denmark	Royal Vet. & Agric. University, Frederiksberg	A. Permin
Netherlands	Fort Dodge Animal Health, Weesp	F. Davelaar
USA	University of Wisconsin, Madison	B. Goodger
United Republic of Tanzania	Sokoine University, Morogoro	U. Minga
Nigeria	Obafemi Awolowo University, Ile-Ife	E. Sonaiya
Morocco	Institut Agron. et Vet. Hassan II, Rabat	J. Bell

\* RAH = Research agreement holder.

**Table 2.** Partners.

Country	Institute/organisation	Name of observer
United Nations	AGAP, FAO, Rome	R. Branckaert
United Nations	AGAH, FAO, Rome	K. Wojciechowski
United Kingdom	VEERU, Reading	R. Oakeley
Australia	University of Queensland, Brisbane	P. Spradbrow

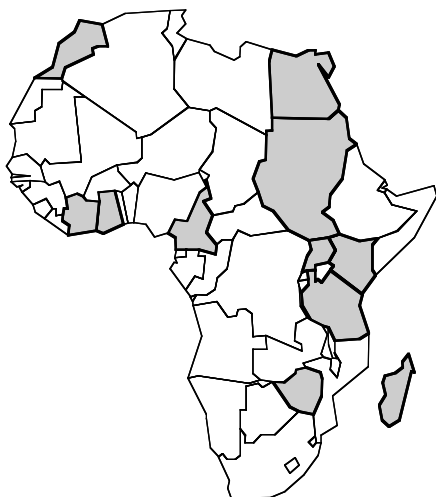
**Table 3.** Research contract holders.

Country	Institute	Name of CSI*
Cameroon	IRZV/IRAD, Bamenda	F. Ekue
Côte d'Ivoire	LANADA, Bingerville	T. Danho
Ghana	Accra Vet. Lab., Accra	G. Opoku-Pare
Kenya	Central Vet. Lab., Kabete	S. Njue
Madagascar	DRZV, Antananarivo	Kokoz
Mauritius	Agric. Res. Ext. Unit, Reduit	V. Juggessur
Morocco	Institut Agron. et Vet. Hassan II, Rabat	F. Kichou
Egypt	AHRI, Cairo	A. Amin
Sudan	Univ. of Khartoum	M. E. Mohamed
Uganda	LIRI, Totoro	J. Illango
United Republic of Tanzania	ADRI, Dar-es-Salaam	H. Msami
Zimbabwe	Central Vet. Lab., Harare	J. Nqindi

\* CSI = Chief scientific investigator.

live vaccines, injectable inactivated vaccines, and recombinant vaccines. The different types of vaccine are compared by Bell elsewhere in these Proceedings.

FAO/IAEA Coordinated Research Programme to improve family poultry production in Africa



**Figure 1.** Map of Africa showing the countries, where research contract holders are located participating in the coordinated research program.

Similarly, the various diagnostic and serological techniques to monitor Newcastle disease control campaigns have been assessed (Cadman et al. 1997). It was decided that the RCH should come to the next meeting with a recommendation as to which vaccine should be used or tested in his/her country to protect the birds against Newcastle disease. If production is feasible locally, the use of a thermostable vaccine I-2 as an eye drop application should certainly be considered. In addition, the most appropriate way for serological and diagnostic monitoring of immunity was discussed.

An existing detailed questionnaire for collecting baseline data on family poultry production was distributed (Kitalyi 1998). The questionnaire was considerably revised during the meeting, with the assistance of comments from field workers in Zimbabwe who had tested the form extensively.

Guidelines for the fieldwork were designed to assist the RCH in the research activities during the first year. It was decided that during the first 18 months baseline data should be collected from 24 different family poultry farms by each RCH (2 different ecological zones; 3 villages in each zone; 4 farmers in each village). The farms will be sampled twice (once during the rainy season and once during the dry

season). It was advised to translate the survey into the local language and test the survey in the field before use. In addition, the RCH were strongly advised to explain the various steps of the research project (survey, sampling, interventions, training) to the village elders or chiefs before entering individual farms. Two different surveys will be conducted by the RCH: a baseline survey in 24 farms (twice) and a disease survey (continuous). Completed questionnaires will be entered into a standardised Excel data input sheet and analysed for factors constraining family poultry productivity in each ecological zone. The spreadsheet will assist uniformity in data collection and facilitate data analysis.

Furthermore, serum samples are to be collected as part of the continuous survey from at least 6 adult animals on each farm. Sick or dead chickens will be collected for post-mortem examinations as described by Permin and Hansen (1998). Sample collection may be facilitated by employing a veterinary assistant stationed in the village.

### Second research coordination meeting

During the second RCM planned for September, 2000, in Morogoro, Tanzania, the results of the surveys will be presented by each RCH. Analysis of the survey results will highlight the regional constraints in poultry production during the two seasons. The RCH will propose protocols to test the most appropriate interventions, measure production increase and immune response and propose improvements in market accessibility. An in-depth analysis of the data obtained from the country surveys will be presented by scientists from the University of Wisconsin to identify differences and similarities between poultry production systems in the different zones.

Following the second RCM, interventions will be initiated on the selected farms in order to improve productivity, as measured by number of eggs produced, number of chicks reaching adulthood and number of birds and eggs sold. Interventions will consist of providing one or more of the following measures depending on local conditions and the factors limiting production: vaccination, other disease preventive measures, supplementary feeding and simple housing structures.

### Future Activities

The project intends to develop specific sets of guidelines for increasing family poultry production adjusted according to region, country and season. The guidelines, together with the research results from the individual scientists, will be published as an IAEA

Technical Document. The practical guidelines will be distributed to a wider audience in a more simplified form. To assure sustainability of production improvements it will be important to involve extension workers and village community organisations.

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# Improving the Health and Productivity of the Rural Chicken in Africa: Research and Development Efforts in Tanzania

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## *Abstract*

This paper describes research and development efforts in Tanzania aimed at improving the health and productivity of rural chickens. Scavenging local chickens (SLC) have the potential to contribute enormously to food security in Tanzania once off-take improves. This can be achieved through step-wise improvements in the SLC production system. In Tanzania, Newcastle disease (ND) has been singled out as the most devastating disease of SLC and studies on the thermostability of NDV4-HR, the use of local feeds as carriers for the vaccine and the molecular epidemiology of ND virus have been undertaken. ND extension packages are also being tested.

TANZANIA has a human population of 30 million and land area of 945 000 km<sup>2</sup>. About 80% of the people live in rural areas where the per capita income is low. It has a relatively large livestock and wildlife population. There are about 15.6 million cattle, 10.7 million goats and 3.7 million sheep. There are 11 national parks, 18 game reserves and 56 game controlled areas, which occupy a total of 23.2 million hectares of land (Melewas 1999).

The livestock industry contributes 18% to the gross domestic product (GDP) and 30% of agricultural GDP. About 70% of livestock GDP originates from cattle and 30% from other livestock, including poultry, which contributes about 16% (Melewas 1989a, b).

There are about 400 veterinarians, the majority of whom are employed by government while others are self-employed either as private practitioners or owners of drug distribution businesses. There are more than 1000 paraveterinarians, or animal health

and production technicians who have certificate and diploma level training. There is, therefore, enough qualified manpower to improve the production of poultry in Tanzania, if given adequate financial and other resources.

The poultry industry in Tanzania is not well developed. Although chicken production on a commercial scale started in the 1960s, it has made minimal impact economically and nutritionally. The commercial sector has performed poorly because of the expensive and poor quality commercial feeds, diseases, veterinary expenses, unreliable supply of day-old chicks, and limited credit facilities. As a result, commercial chicken meat and eggs are expensive and consequently consumption is low. Under prevailing economic conditions, the scavenging local chicken (SLC) therefore appears to be a better alternative to the commercial chicken because it requires minimal inputs in terms of finance, manpower and land resources and hence the final product can be made affordably cheap.

However, the SLC has been neglected and limited efforts have been made by government, non-government organisations (NGOs) and farmers to improve their health and productivity. Improved health and productivity of the SLC would have a direct positive impact on farmers' income and nutrition.

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### Productivity Indices of the Scavenging Local Chicken in Tanzania

There are 28.3 million poultry in Tanzania, and of these 26.6 million (94%) are the SLCs, while 0.5 million (1.8%) are the commercial broilers and layers and the remaining 1.2 million (4.2%) are other poultry, mainly ducks (3.4%) (MOA 1995).

About 72% of the rural households keep the 26.6 million chickens with an average of 10 chickens per household (Livestock census 1994), although other and more recent studies have reported a higher figure of 23 chickens per household (Mwalusanya 1998).

The productivity indices are relatively low among the SLC. In a study made at Sokoine University of Agriculture in 1989 (Minga et al.) and 1996 (Minga et al.), it was reported that the average adult body weight was 1538 g (range 800–2450 g) and 1864 g (1650–3800 g) for hens and cocks respectively. The average egg weight was 41.8 g with a range of 25 to 56 g. The growth rate under a scavenging system varied from 0.9 g to 30.2 g per day for chicks and growers, but the rate differed depending on age and initial weight. Mwalusanya (1998) reported that the average growth rate from day-old to 10 weeks of age was 4.6 g and 5.4 g per day for female and male chicks respectively. Hens laid an average of 40 eggs per year in three clutches. The average clutch size was 11.8 eggs, and hatchability ranged from 62% to 89%, with an average of 83.6%. Mwalusanya's 1998 study reported that the mean cock to hen ratio was 1:4.3. In another study, Minga et al. (1996) reported the ratio of chicks to growers to adults as 10:5:6, and that might explain the low off-take rate, which is experienced in the sector. The per capita consumption of poultry meat and eggs is 0.7 kg and 13 per annum respectively, while the world average is 6.8 kg of meat and 108 eggs.

Studies have shown that SLC are heterogenous as shown by their phenotypic characteristics. (Lawrence 1998). In Tanzania, Lawrence (1998) identified five ecotypes based on their geographical origin and phenotypic characteristics: Kuchi; Singamagazi; Ching'weke; Morogoro medium; and Mbeya ecotype. The ecotypes differ in several aspects:

- Kuchi from Mwanza region has an adult body weight of 2708 g and 1827 g for cocks and hens respectively, with an average body length of 25.2 cm. The egg weight is 45 g and shank length is 13.3 cm.
- Singamagazi from Shinyanga region with adult weight of 2915 g and 2020 g for cocks and hens respectively, has a body length of 26.4 cm and 22.4 cm. The average egg weight is 45 g. The shank length is 13.9 cm and 10.9 cm.

- Mbeya from Mbeya region has adult body weight of 1621 g and 1394 g for cocks and hens respectively. The ecotype has a body length of 23 cm and 20.2 cm for cocks and hens. The shank length is 12.4 cm and 10.2 cm. The average egg weight is 41 g.
- Morogoro Medium from Morogoro region has an adult body weight of 1850 g and 1107 g for cocks and hens. Body length is 24.2 cm and 21.1 cm and shank length is 12.0 cm and 9.7 cm. The egg weight is 38 g.
- Ching'weke (Morogoro short) from Morogoro region has an adult body weight of 2100 g and 1441.7 g for cocks and hens. Body length is 23.3 cm and shank length is 10 cm and 8.2 cm for cocks and hens. The average egg weight is 37.7 g. Lawrence (1998) reported that immunocompetence as measured by production of anti-sheep red blood cells antibodies did not differ significantly between the five ecotypes. There was no difference between the ecotypes in their susceptibility to Newcastle disease (ND) virus infection and *S. gallinarum* infection except for Kuchi ecotype which survived *S. gallinarum* challenge. Serological MHC typing which was conducted by Lawrence (1998) revealed that it was difficult to do MHC typing of the ecotypes using serological methods which rely upon alloantisera originating from exotic commercial breeds. Lawrence (1998) tested 15 alloantisera with B-F and B-G specificities. Although it was shown that the BF 121 was the most frequent type, it was not specific for any particular ecotype. There were cross-reactions and some chickens could not be typed by using the 15 alloantisera.

In Tanzania, Tibamanya (1994) reported that the SLC takes 108 to 161 days to accomplish one production cycle thus:

No. of Days	Activity
20	Laying 15 eggs per clutch
21	Incubating
60–90	Brooding
7–30	Regaining

Therefore, a total of 108–161 days are required to achieve three production cycles per year and produce a total of 45 eggs.

### The Challenges

The big potential of the SLC has not been realised and utilised in Tanzania because of a number reasons. The major reasons are (a) chicken losses through various causes, (b) the low genetic potential, (c) low plane of nutrition, and (d) poor husbandry system which is a low or near zero input extensive

type (Minga et al 1989; Kitalyi 1998). The low input, low output husbandry system is characterised by poor nutrition, poor or no housing facilities, non-selective breeding, no veterinary interventions and lack of provision for rearing chicks.

In an earlier study by Minga et al. (1989), it was reported that the main cause of chicken loss among the SLC occurs during chickhood and averages 50%. The other losses of growers and adult chickens are due to chicken diseases, predators and theft. Chicken loss during adulthood is mainly due to diseases, especially ND.

Loss due to disease outbreaks can be substantial. Whereas commercial chickens are regularly vaccinated against ND, the SLC are rarely, if ever, vaccinated against the disease. In Tanzania, ND has been singled out as the most devastating disease, whereby whole village populations may be decimated. The greatest loss due to ND occurs during the hot and dry season starting from July up to the start of the short rains in October to November. However, sporadic outbreaks do occur in between. (Yongolo 1996). The other infectious diseases, which affect SLC in Tanzania, include collibacillosis, fowlpox, infectious coryza, fowl typhoid and Gumboro disease (IBD) (Minga and Nkini 1986). Parasitic diseases of importance are helminthoses and the ectoparasites, especially fleas and mites (Permin et al. 1997). Fowl typhoid assumes greatest importance among commercial chickens, and frequent outbreaks have been experienced in hatcheries as well as among the commercial layers. Fowl typhoid is economically the most important disease affecting the commercial chicken industry and has a high incidence in Tanzania. (Minga 1986; Mdegela 1998).

The availability of feeds for the SLC is irregular and varying in quality. During the rainy season, there is an abundance of green vegetation, wild grass seeds and insects. Towards the end of the rainy season and beginning of the dry season when grains are harvested, there is abundant supply of grains and kitchen leftovers. During the dry season, however, grain supplies dwindle and insect populations decline. There is very little feed supplementation. Rarely are the SLC fed on whole grains but rather spoiled grains and the brans which are left over after milling the grains. Such erratic feed supply cannot be expected to sustain high chicken productivity levels. It has been estimated that the SLC feed consumption provides to the chicken only 11 kcal metabolisable energy and 11 g of protein per day, and that amount of feed is inadequate for optimal productivity and below what is needed for maintenance (Kitalyi 1998).

Mwalusanya (1998) reported that the main components of crop contents of SLC were cereal grains,

bran, green forages, insects and worms. The chemical composition of the crop contents were: 43% dry matter, 10% crude protein, 5.8 crude fibre, 12.5% ash, 0.66% calcium and 0.4% phosphorous.

## Research

In Tanzania, some limited research has been conducted:

- Crossbreeding experiments (MSc and PhD theses).
- Prevalence of diseases among SLC has been studied, but mainly ND, Fowl typhoid and helminthoses. (Papers and MSc and PhD theses).
- Some ecotypes have been identified and disease resistance has been studied on a small scale (MSc thesis).
- Studies on productivity and nutritional status of the local chickens under village management conditions (MSc dissertation).
- The molecular epidemiology of fowl typhoid (MSc dissertation).
- The thermostability of the NDV4-HR vaccine at room temperature and efficacy (results are contained in the country report of these proceedings).
- Studies on the use of various local feeds as carriers for the NDV4-HR vaccine.
- Studies on the molecular epidemiology of ND virus are in an advanced stage.
- Molecular typing of the SLC ecotypes in Tanzania is in an advanced stage.
- A study to determine the value of the traditional medicinal plants in the treatment of chicken diseases.
- Studies on flock dynamics; more research is planned.
- Nutritional studies (Part of an MSc dissertation).
- Crossbreeding programs using hybrid cockerels as an extension package.
- NDV4-HR and I-2 ND vaccination extension packages have been tested and are continuing to be tested (reported in the country report of these Proceedings).

## The Way Forward

It has been shown above that the productivity indices of the Tanzanian SLC are low. The ratio of chicks to growers to adults of 10:5:6 shows that 50% of the chicks hatched are lost before reaching adulthood. Chick loss is due to diseases, poor husbandry, and predators. The cause and magnitude of the loss, which occurs among growers and adult chickens, has not been precisely determined in Tanzania. Unpublished observations indicate that the loss which occurs when chickens have reached the grower and adult age is lower than in chicks. However, there is

periodic loss of adult chickens mainly due to infectious diseases, especially ND.

Surplus chickens available for disposal are few because of the off-take rate which is very small. The number of eggs produced per chicken per year is very low. The size of the egg and of the adult chicken is small. It was previously thought that the zero input extensive husbandry system which the SLC are subjected to cannot be expected to have any meaningful out-put. However, during the 1998–99 drought which affected some parts of Tanzania, it was realised that livestock plays an important role in food security when livestock were sold to get cash to purchase food grains. Therefore, the SLC has the potential to contribute enormously to food security once the off-take improves. It was stated by MacGregor and Abrams (1996) that 12 laying hens per household would reduce the incidence of malnutrition in the resource-poor households.

The constraints experienced by the SLC sector must be solved in order to increase the production of the SLC. Once those constraints have been tackled, the chicken population will increase, off-take rate will increase, which could then be translated into better income and nutrition of rural people. A moderate increase of off-take would easily be accommodated by the current level of the economy and will force prices down. Experience in Tanzania shows that SLC meat is preferred to the commercial chicken meat on account of their perceived better taste and lack of residues, especially hormones. There is thus a good market for the SLC in urban areas in Tanzania. Preliminary results of a market survey in Morogoro, indicates that there is a big market for SLC in urban areas. The number of scavenging local chickens transported to Dar-es-Salaam and Morogoro using the Dodoma highway is being collected at a traffic police checkpoint near Morogoro town.

So far, data for two months (January and February) have been collected and the following are the preliminary results:

<i>Destination and month</i>	<i>Average number of chickens transported per day</i>	
	<i>January</i>	<i>February</i>
Dar-es-Salaam	430	304
Morogoro	114	108
Total	544	412

Hence, the expected number of chickens to be transported for 12 months is for Dar-es-Salaam 133 955 chickens and for Morogoro 40 515 chickens.

The average price per chicken in Dar-es-Salaam is 2150 shillings, therefore total estimated sales in

Dar-es-Salaam for one year would be 288 003 250 shillings (US\$360 004).

The average price per chicken in Morogoro is 1300 shillings, therefore the estimated total sales per year in Morogoro is 52 669 500 shillings (US\$65 837).

Therefore, figures indicate that even when no intervention has been done to improve the health and productivity, the contribution of the SLC industry to the economy of the country is substantial.

### **Improvement in Production**

The potential of the SLC in Tanzania may be gauged by using a simple model which is based on an assumption that chicken loss can be kept to a minimum, which is a difficult ideal to achieve, but possible if major diseases are controlled.

It has been stated above that in Tanzania, the chick, grower, adult ratio is 10:5:6 which means, of the 26.6 chickens, there are 12.7 million chicks, 6.3 growers and 7.6 adults. Assuming a cock to hen ratio of 1:4 (Mwalusanya 1998), the hen population is 6.08 million. If in an improvement program chick loss is reduced to 10%, then after one year, there will be 11.43 million growers. Assuming a grower loss and replacement will take 2% of the growers, the surplus will be 11.2014 million adults. The value of the surplus chickens will therefore be 16 802 100 000 shillings (US\$21 002 625). With sustained disease control efforts, the ratio of chick to grower to adult will be 37:29:1. This is based on the assumption that one hen would lay 45 eggs per year which will have hatchability of 83%. The chick loss will be at 10%; egg consumption, and grower loss and replacement of parent adult chickens will be 2%. Hence, the ratio will be 30:29:2 for chick, grower and adult chicken.

The total chicken population has been estimated to be 26.6 million, a figure obtained by using a questionnaire. We have learnt through experience that farmers do not include chicks when giving population figures but rather count only growers and adults. On that assumption then, the adult population might be 13.3 million (half of 26.6 million), and of these 4 in 5 would be hens and hence 10.88 million hens. By that argument, if disease is reduced to 10% and 2% chick and grower loss respectively, and ratio is 30:29:1 (chick:grower:adult), those hens would produce a progeny of 315.52 million adult chickens per year worth 473 280 000 000 shillings (US\$591 600 000) equivalent to 4 930 000 head of cattle. That ideal is unlikely to be achieved, but if it were to be achieved the domestic market would be unable to absorb it and alternative marketing strategies would have to be worked out. These figures are meant to emphasise the

importance of the SLC. It could be a big industry, especially where biologically farmed animals and their products are preferred.

One big constraint which hinders the expansion of the chicken population is feed. Improved feeding regimes for SLC are constrained by shortage of the main ingredient in chicken feeds, which is food grains such as maize. As Sonaiya (1995) stated, where there is no self-sufficiency in food grain production, there will be scarcity of alternative feed-stuffs for compound feed or other locally produced feeds.

In order to realise this big potential in Tanzania, it would require improvement in husbandry, nutrition and increased grain out-put and disease control strategies, but with minimal financial input. Such improvement must be made cost-effective and sustainable. Chick loss must be minimised through better husbandry practices and chickens should be protected from the scourge of ND. Husbandry practices that would minimise the rearing time for chicks would also greatly facilitate the quick build-up of the chicken population.

### **Improvement of Genotype**

The great variation in egg weights, growth rates, adult weight and the lack of MHC typability, as well as the presence of five ecotypes indicates that the SLC in Tanzania is phenotypically and genetically heterogeneous. The phenotypic and genetic heterogeneity and the indication of disease resistance emphasises the biodiversity of SLC and hence SLC are a rich source of genes ideal for selection, breeding and multiplication of the most suitable ecotype which would be most adapted to the local condition. The same was pointed out by Horst (1988) who stated that the genetic resource base of the indigenous chicken in the tropics is rich and should form the basis for genetic improvement and diversification to produce a breed adapted to the tropics. The preservation of the indigenous chicken germplasm and biodiversity was advocated by Bessei (1989).

Programs aimed at improving the health and productivity of the SLC ought to be sustainable in order to have lasting impact on the income nutrition and health of target rural human population (Kitalyi 1998). Kitalyi recommended a step-wise improvement of the SLC production system, and which I would also like to advocate:

- Step 1: Improve hygiene, shelter, preferential treatment of chicks and control of devastating diseases and hence end up with healthy SLC.
- Step 2: Improve management of SLC through supplementary feeding, better housing and

disease control program and formation of farmers group.

- Step 3: Improve SLC productivity through selective breeding, for high yielding traits and for disease resistance. Improve feeding and marketing and formation of producer-consumer associations. Encourage vigorous promotion of the consumption of chicken meat, eggs and chicken products in urban and rural areas. Increased consumption would then create increased demand and thus sustain and promote improved chickens and increase SLC production. In turn it would add to food security, increased income and better nutrition and health for the resource-poor rural populations.
- Step 4: Commercial village chicken production system: Multiplication and distribution of high-yielding SLC types. Promotion of improved and competitive marketing strategies.

### **Research and Development**

There are many areas of research which are unexplored or have inadequately explored the potential of the SLC:

1. Husbandry:
  - Production: Factors affecting production.
  - Nutrition: Assessment of nutritional status of the SLC.
  - Feeding: Optimal feeding regimen using locally available feed ingredients
  - Shelter: Development of appropriate shelter using local building materials.
2. Population dynamics, Genetics (Genotyping), Breeding (Genetic improvement) and multiplication of improved ecotype/haplotype.
3. Infectious and non-infectious diseases: Epidemiology and control.
  - Collection of baseline data, susceptibility trials, disease resistance testing of ecotypes, vaccination trials and treatments.
4. Socio-economics: including gender issues, land, time allocation.
5. Marketing: Optimal marketing strategies.
6. Extension packages: Intervention technologies, development and application.

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# The Smallholder Livestock Development Project, Bangladesh

K. Schleiss<sup>1</sup>

## *Abstract*

This paper describes the Bangladesh Smallholder Livestock Development Project which was started after 10 years of preparation from 1993–1996, in cooperation with the Government of Bangladesh and some non-government organisations. The model is based on semi-scavenging poultry flocks and is defined as a system with poultry flocks under partly controlled management and where the scavenged food accounts for a significant part of the total food consumption. It is an integrated system which provides supplies, services and production components in order to establish and maintain a semi-scavenging poultry sector.

THE Bangladesh Smallholder Livestock Development Project was initiated after 10 years of preparation in 1993–1996 in cooperation with the Government of Bangladesh and some non-government organisations (NGOs), the most influential being the Bangladesh Rural Advancement Committee (BRAC).

Most women of rural, landless households in Bangladesh live in extreme poverty and therefore the model is targeted solely at these landless women.

The initial model was sponsored jointly by the Danish International Development Agency (DANIDA) and the International Fund for Agricultural Development (IFAD). The following phase was sponsored jointly by DANIDA and the Asian Development Bank (ADB), and finally sponsored by DANIDA alone in the late 1990s, when it became a nationwide operational model.

Initially the target group consisted of 270 000 landless women and the aim was to encourage these very poor women to become involved in poultry income-generating activities.

The model is based on semi-scavenging poultry flocks and is defined as a system with poultry flocks under partly controlled management and where the scavenged feed accounts for a significant part of the total feed consumption. It is an integrated system

which provides supplies, services and production components in order to establish and maintain a semi-scavenging poultry sector.

The integrated semi-scavenging production model in Bangladesh is three-pronged, consisting of production, supply, and services:

## **Production Line**

### **Breeders (model rearers)**

Small low-cost parent farms are established with 25 parent hens and cocks per unit. The birds are fed balanced feed and kept in confined spaces. Breeds typically consist of White Leghorn, Rhode Island Red and Fayoumi. Males and females are of different breeds.

### **Mini-hatcheries**

Small low-cost hatcheries are operated with nearly 100% solar energy. Black pillows filled with rice husks are heated in the sun, and the eggs are placed in a cylinder (such as an empty oil drum or similar) between two pillows for hatching. Each hatchery has a capacity to hatch 1000 day-old chicks per month.

### **Chicken rearers**

Small rearing farms are established with a capacity of 200–300 chickens. The birds are reared in a low-cost house from 1 day-old to 8 weeks of age. The

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chickens are fed a balanced diet of feed supplied by the local feed seller.

#### **Smallholders (key rearers)**

These are small farms with only 10 hens, mainly improved breeds that are supplied by the chicken rearers and a few local (Desi) hens. The birds are kept under semi-scavenging conditions, with a supplementary feed supply of 30–70% of the full ratio. The remaining feed is obtained through scavenging.

### **Supply Line**

#### **Parent stock**

The parent stock is supplied by the Directorate of Livestock Services at the market price for day-old chickens. Breeds are Fayoumi, White Leghorn and Rhode Island Red.

#### **Feed**

A number of small feed sellers located in the villages, purchase local by-products from the milling industry and mix it with fishmeal, vitamins and minerals. The feed sellers sell approximately 1 ton of feed per month.

#### **Vaccine/medicine**

A number of poultry workers are trained to vaccinate the birds. The vaccine is supplied free of charge by the Government, but the poultry worker charges a vaccination fee.

#### **Marketing**

The eggs are collected by egg collectors and marketed in the nearby towns and urban areas. Alternatively, the smallholder sells her eggs and chickens in the village.

### **Service Line**

#### **Group formation**

The involved NGOs form small village groups with some 30 members. The groups hold weekly meetings to discuss relevant subjects and new members are selected from the groups.

#### **Training**

Before a poultry holder is established, she goes through a 3-day training program which is followed later by refresher courses.

#### **Credit**

Depending on the activities each member is provided with a small loan ranging from US\$25 to US\$200. The re-payment period is 1 year.

#### **Extension**

Extension services are provided as a cooperative effort between the Government and the involved NGOs.

The organisation of the model is well developed and is functioning well, but there is still a big gap with regards certain technical aspects. The scientific resource base for semi-scavenging poultry holdings is rather weak, and therefore a professional Poultry Network was established at the Royal Agriculture and Veterinary University, Copenhagen (Danida funded), in 1997.

### **Smallholder Structure**

Smallholders constitute 95% of the units in the model, and the units are rather complex, as they comprise several activities, such as production of eggs, pullets, spent hens, and cockerels. The flow of activities also includes management, feeding, and marketing. This complexity of activities makes it possible for the individual smallholder to adapt her operation to the prevailing market conditions and demands.

### **Transfer of Technology**

The structure of the model in many ways mirrors an entire poultry sector, with parent stock, hatchery, rearers, broilers and egg producers. The infrastructure is further supported by the supply and service functions as integral parts of the model. The concept of the model is that approximately 10% of the population in the project area are directly involved in any of the activities, either as producers or in the supply and service activities.

The cornerstone in the semi-scavenging system is that scavenged feed constitutes a substantial part of the total feed consumption. As such there are two pre-requisites to the system:

- scavenged feed must be available in sufficient amounts; and
- birds must have safe access to scavenge the available feed.

### **Conclusions**

The Poultry Model developed in Bangladesh is the most structured and the most carefully designed smallholder poultry program in any developing

country. Chicken mortality has been reduced to an acceptable level, and the resource consumption, mainly feed, even seems to be competitive with the intensive poultry production

Impact surveys show that 20%–30% of households have moved above the poverty line within the first year of implementation, and due to increased earnings women have been able to buy more food, send children to school and increase physical assets, including purchase of land. The women's participation in decision-making in the household has increased.

Very few projects have recorded the same level of impact. Employing this particular model has so far been confined to Bangladesh, but it is concluded that the results achieved clearly indicate that the model

could be applied in other countries. There is no doubt that the model is viable and sustainable, but there is, however, a great potential for technical improvements and adaptation to conditions in other developing countries.

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# Poultry as a Tool for Poverty Alleviation: Opportunities and Problems Related to Poultry Production at Village Level

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## *Abstract*

Poultry, the largest livestock group, account for more than 30% of all animal protein. However, this production is mainly based on commercial poultry, which accounts for only 20% of the total poultry population. The remaining 80% of poultry are found in traditional production systems entitled 'low input – low output' systems. Here the mortality is around 80% within the first year after hatching. The constraints for improving productivity are, however, not only related to diseases (e.g. Newcastle disease) but also to management systems, lack of supplementary feeding, predators, and inappropriate breeds. Despite their low productivity, village poultry are owned by almost all poor households in developing countries and are thought to be an excellent tool in poverty alleviation due to their quick turnover and low investment requirement. In Bangladesh, a successful production model has been developed which currently involves more than 2 million women (households). This model has a structured approach to improve smallholder poultry production and health, and socio-economic development at village level and it addresses both technical and organisational issues. These aspects are discussed in this paper.

POULTRY is by far the largest livestock group and is estimated to be about 14 000 million, consisting mainly of chickens, ducks and turkeys (FAO 1999). In total, poultry products (egg and meat) constitute 30% of all animal protein consumed worldwide. Within the last 10 years, this proportion has increased from 20% to 30% of all animal protein and is predicted to increase to 40% before the year 2015 (IFPRI 2000). Poultry production in most developing countries is based mainly on scavenging backyard systems. For example, it has been estimated that 80% of the poultry population in Africa is found in traditional production systems (Gueye 1998) called low input/low output systems. Little attention is given to this means of production even though 30% to 100% of the animal protein consumed in some villages is from this source. This low input/output practice has been a traditional component of small farms all over the developing world for centuries and is thought to continue as such in the future.

The low output is primarily caused by diseases, lack of supplementary feed and sub-optimal management (Pandey 1992; Bagust 1994 and 1999; Permin and Bisgaard 1999). Poultry production still accounts for the major part of all meat produced in many developing countries, and is an integral component of nearly all rural, peri-urban and urban households. It is of considerable significance to the rural as well as the national economy and is also an important source of animal protein (FAO 1999). Women and children are generally in charge of poultry husbandry. Generally, poultry scavenge in the vicinity of the house during daytime where they may be given sorghum, broken grains, maize bran or other waste products as additional feed. In many circumstances, they are not given anything at all, but have to walk long distances (up to four kilometres per day) to find feed and water (Gueye 1998). Additional feed is then occasionally given at night where the animals are kept inside the houses or in simple shelters. The level of productivity is very low compared to high-input systems; for example, a scavenging hen lays only 30 eggs per year, while an industrialised battery hen lays 280 eggs annually.

Disease prevention measures are rare and high mortality rates are common (Pandey 1992). Studies

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in Nicaragua and Mali (N. Kyvsgaard 1999 pers. comm.; Wilson et al. 1987) have shown chick mortality to be in the range of 30% to 40% within the first three to four months after hatching. In Nigeria, Matthewman (1977) reported a mortality of more than 80% within one year after hatching. The constraints for improving productivity are, however, not only related to diseases but also to management systems, lack of supplementary feeding, predators, and inappropriate breeds for the environment (Bagust 1994 and 1999). In the case of backyard poultry that scavenge, feed costs are kept at a low level and do not seem to represent the main constraint for production. Diseases, predators, and management factors appear to be more important for survival of the individual bird and for the overall productivity of the flock.

Despite the many problems involved in keeping poultry, almost all poor households, including the landless, own poultry. Thus, if production could be improved, poultry would create an opportunity for development of the poor segments of a society (Gueye 1998; Todd 1998; Quisumbing et al. 1995). Experience in several countries points to a number of reasons why poultry can be used in a way that makes it an excellent tool for poverty alleviation (Todd 1998). Some of these reasons are:

- nearly all households (poor and landless) own poultry;
- poultry is mainly owned and managed by women and children;
- there are few religious taboos related to poultry;
- poultry is socio-culturally important;
- low cost technology is available;
- low investment is needed;
- land is not needed; village poultry production is relatively environmentally friendly;
- 10 chickens under improved conditions are enough to make a difference for one household;
- poultry production can be a self-sustaining and income-generating system; and
- poultry production can serve to build up an entitlement base for poor women.

In spite of the importance and the potential of backyard poultry, few activities have successfully improved the output. Development projects have traditionally focused on vaccine production and vaccination campaigns, cockerel exchange programs, and institution building. 'Imitations' of intensive commercial systems have, in some cases, been successful from an economic point of view, but have not necessarily alleviated poverty. The effects of previous projects have been small because these projects have not focused on a coherent production and management system for rural poultry production. It is unlikely that an isolated technical intervention

aimed at any one constraint could in itself make a significant difference at production level. Instead, a multidisciplinary approach is required to improve the productivity and health of poultry under village conditions.

### **The Bangladesh Model**

The many problems faced in smallholder poultry production systems have for some time attracted special attention in Bangladesh. Over the past two decades, a successful approach, known as the Bangladesh poultry model, was developed as a collaboration between the government (Department of Livestock Services (DLS)) and NGOs (Saleque and Mustafa 1996; Jensen 1996; Ambar and Rahman 2000). So far, women from about two million poor households have been involved in the model. With the ability to reach especially poor women, and create additional income for the households, the model has proven to be a viable poverty alleviation tool (Alam 1996 and 1997). This model, being a structured approach to improve smallholder poultry production and health and socio-economic development, addresses both technical and organisational issues (Table 1 and Figure 1):

- On the technical side, the main idea is to establish a large number of small household-based production units, the so-called key rearers. Each key rearer will be supplied with a small number of improved breeds, simple technical tools, and access to supplementary feed. The key rearers are also supported by vaccination programs, by provision of training, awareness raising, micro credit, by input supplies, and marketing established within the local community, thus making up an integrated production chain with a minimum dependency on external inputs (Table 1 and Figure 1).
- On the organisational side it is realised that government agencies have limitations in resources, which makes it difficult for these agencies to provide services directly to a large number of poor people in the rural areas. The NGOs, on the other hand, have developed grassroots-based operational networks and a participatory approach, which involves community organisation, awareness raising activities, vocational training, saving and micro-credit schemes, and often a long-term commitment in an area.

All units at village level must operate on free market principles, which is important for the model to be economically sustainable. The approach includes direct targeting of women.

**Table 1.** The components of the three-line organisation of the poultry model (adapted from DANIDA 1999).

A. Primary production	B. Input supply and marketing	C. Services to establish and maintain the model
<p><i>1. Mini hatcheries</i> Small low-cost hatcheries operated with solar energy and kerosene. Black pillows filled with rice husks are heated in the sun or by means of a kerosene lamp, and the eggs are placed into a cylinder between two pillows for hatching. Each hatchery has a capacity to hatch 1000 chickens per month.</p> <p><i>2. Chicken rearers</i> Small rearing farms, each with a capacity of 200–300 chickens-4 batches per year. The chickens are reared in low cost houses from day-old to 8 weeks of age. The chickens are fed with balanced feed supplied by the local feed mixers and sellers.</p> <p><i>3. Pullet rearers</i> Small rearing farms which receive 8-week-old pullets from chicken rearers (or government farms) and rear them to the age of 18 weeks.</p> <p><i>4. Model breeders</i> Small low-cost parent farms with 25 parent hens per farm. The hens are kept in confinement and fed with balanced feed. The parent stock is either RIR males and Fayoumi females or Fayoumi males and commercial hybrid females.</p> <p><i>5. Key rearers (95% of the beneficiaries)</i> Small farms with only 10 hens, mainly improved breeds supplied by the chicken rearers, and a few hens of local breed. The hens are kept under semi-scavenging conditions and fed with 30–70% supplementary feed.</p>	<p><i>1. Parent stock</i> The parent stock is supplied from government or NGO hatcheries at market price for day-old chicken.</p> <p><i>2. Feed mixers and sellers</i> The feed is supplied by a number of small feed sellers located in the villages. The sellers purchase local by-products from the milling industry and mix it with fishmeal, vitamins, and mineral. A feed mixer and seller prepares and sells about 1 ton of feed per month.</p> <p><i>3. Poultry workers</i> A number of poultry workers are trained to make simple diagnoses and vaccinate the birds. The vaccine is supplied by the government and the poultry workers charge a vaccination fee.</p> <p><i>4. Egg collectors</i> Table eggs and chickens are collected from the key rearers by egg collectors and marketed in the nearby towns, or the poultry holders sell the eggs and chickens themselves in the village.</p>	<p><i>1. Surveys and group information</i> The involved NGOs perform area and household surveys. Potential beneficiaries are selected based on poverty criteria and organised to form small village groups with some 30 members each. The groups hold weekly meetings to discuss relevant subjects and new poultry holders are selected from the groups.</p> <p><i>2. Training</i> Before a poultry holder is established, she has been through a 3–day training program followed by refresher courses.</p> <p><i>3. Credit</i> Depending on the activities, each group member is provided with a small loan ranging from US\$25 to US\$200. The repayment period is one year.</p> <p><i>4. Extension</i> Extension services are provided as a cooperation between the government and the involved NGOs.</p> <p><i>5. Research</i> Research is conducted as per identified needs by national and international universities and sector research institutions.</p>

The fundamental idea of the integrated poultry production model is based on a three-line organisation: a) primary production, b) input supply and marketing, and c) services (Table 1). The first and the second line contain the components, which make up the actual poultry production and input supply at village level (except for input of parent stock). The third line contains the implementation and extension services of the government and the NGOs, as well as the research component. However, while Table 1 explains the various components of the model, the diagram in Figure 1 illustrates the dynamics of the poultry model as it is currently applied in Bangladesh.

#### **Strengths and weaknesses of the Bangladesh model**

The poultry model has shown to be a viable tool for poverty alleviation. This is further supported by two

impact studies carried out in relation to the initial project (Alam 1996 and 1997). The strength of the model is a combination of technical features and a means of implementation, which, among other things, directly targets the poor. The following technical features facilitate the involvement of poor people:

- the model requires no assets to begin with;
  - it is based on traditional poultry rearing knowledge;
  - required inputs are (mostly) locally available;
  - it has a built-in marketing and sales mechanism (aiming at village and local markets); and
  - activities are inter-linked (community groups involved).
- The achievements include:
- actual participation of poor women;
  - social awareness raising;

- empowerment of women (women influence on household decisions);
- employment opportunities and income generation for the poor; and
- nutritional status in households improved.

On the other hand, there are clear weaknesses and need for further improvement of some of the model components and the way the model is implemented. This was clearly identified during recent workshops conducted in Bangladesh by the Network for Small-holder Poultry Development. For instance:

- some of the technical packages can be improved and made more economically viable;
- supply of external inputs such as parent stock, vaccine, and feed ingredients needs to be better secured;
- training of trainers (i.e., training of NGO staff) must be more effective to improve the quality of the NGO staff's training of beneficiaries; and
- though involvement of both government agencies and NGOs is a strength, attention must be paid to

further develop operational procedures, which will overcome the institutional differences between the involved partners and provide clear guidelines for division of work and responsibilities.

### Conclusion

The positive experience from the activities in Bangladesh, based on the involvement of almost two million poor women, shows that poultry production can be used as a viable tool in poverty alleviation. Poultry production can be a tool for improving the immediate welfare in households, especially for women and children. Furthermore, the small but regular income from poultry rearing activities in the hands of women may constitute an important starting point for strengthening the position of women in the households and the community in general (Alam, 1996 and 1997). This is partly due to the fact that income earned by women typically remains under

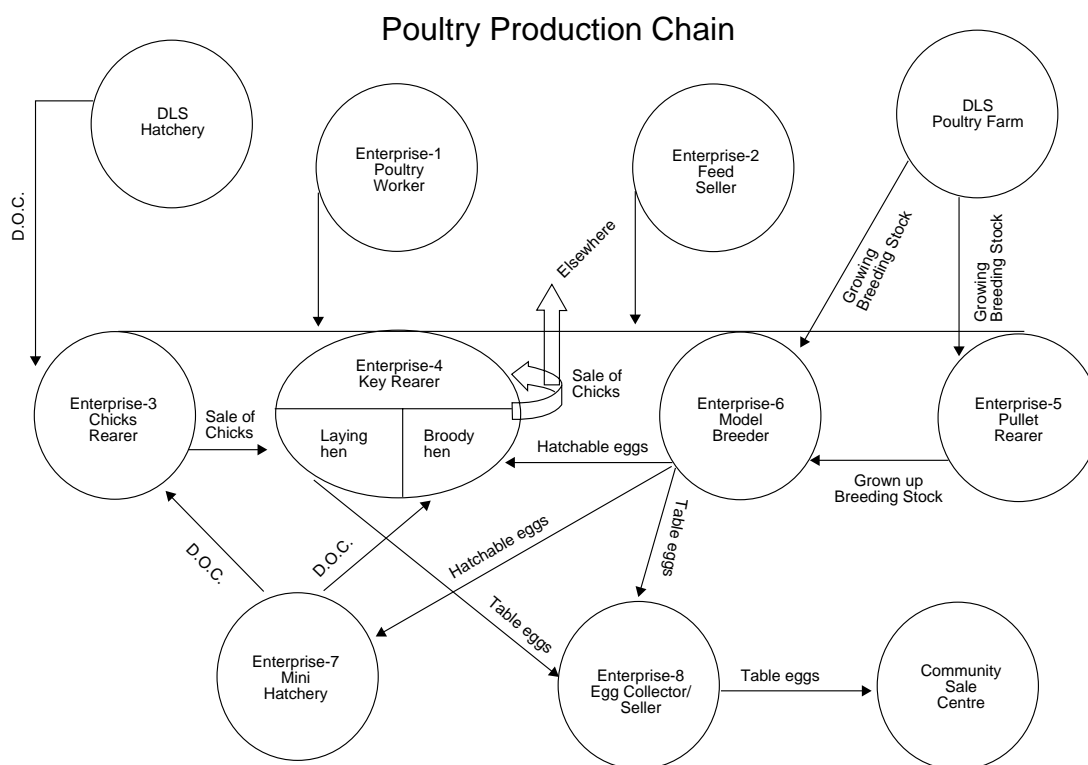


Figure 1. Diagram of the poultry production chain as currently applied by The Government of Bangladesh (DANIDA/Darudec 2000).



the control of women (Quisumbing et al. 1995; Todd 1998). Experience from various projects, in Bangladesh and outside, also shows that considerable attention is needed to adapt the poultry model to the cultural, technical, economic, and institutional situation in the target country.

Over the years, many donors, including Danida, IFAD, WFP and ADB have supported the poultry projects in Bangladesh with funding and technical assistance. In acknowledgment of the importance of the traditional poultry production systems in the developing countries, DANIDA has supported the establishment of the Network for Smallholder Poultry Development, which is focussing on poultry production at village level in Africa and Asia. The main objective of the Network is to analyse the experience from Bangladesh, and develop a conceptual framework, which can be applied to projects in other developing countries. This will include support to design and implementation of such projects as well as to capacity building, research, training and education.

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# A Survey on Village Chicken Losses: Causes and Solutions as Perceived by Farmers

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## *Abstract*

The survey was conducted to examine poultry production and determine causes of poultry losses in a communal area of Zimbabwe. Qualitative data were obtained using participatory rural appraisal (PRA) techniques, while quantitative data were captured through a structured questionnaire administered to 416 households. The majority (68%) of the farmers in the study kept indigenous chickens and the remainder had exotic broilers and layers. Ownership of poultry was similar among men and women. In terms of management, indigenous chickens survived mainly through scavenging with minimal or no supplementary feeding provided. Health management was also poor, with minimal use of veterinary therapeutic intervention in the event of disease outbreak. The major causes of losses were disease, predators and external parasites, as well as thieves. The occurrence of disease and predator problems was seasonal, the former being high during the hot season. Reasons given for high mortality during the hot season were improper housing and the heat. In addition, mortality was highest in young chicks, particularly during the first three weeks after hatching. The major disease problems were Newcastle disease (ND) and coccidiosis, while the main predators identified included dogs, baboons, and several nocturnal feral cats. In conclusion, the major findings of this study were that there is an abundance of indigenous chickens and farmers attach great importance to them in their daily lives but take very little care of them. However, the farmers are aware of the potential benefits that can accrue from improving productivity of poultry. Given the opportunity, farmers would like to improve poultry housing and care of chicks, improve on disease prevention and control, particularly ND.

IN ZIMBABWE, village chickens are estimated to number between 15 and 30 million. This estimate is based on about one million communal farmers, each keeping an average of 20 birds. Village chicken production has withstood the test of time and is often described as a low input-low output production system. This makes it a very sustainable system for the resource poor communal area farmers. Because of this attitude, very little attention has been paid to this industry in terms of research and development, resulting in the lack of information on the status of poultry production in the communal areas. This lack of attention has led to many constraints in terms of improving productivity of village chickens, not only in Zimbabwe, but also in other African and developing

countries. On the other hand, commercial production of the different classes of poultry has increased over the years and is poised to grow in Zimbabwe. This is a direct response to the increased demand for poultry meat as a substitute to beef in the general consumer's diet due to the ever escalating and inflated prices of beef. In addition, village chickens are important for various social and traditional rituals and will always be part of the farming systems in the communal areas of Zimbabwe (Scoones 1992).

Village chickens play a very important role in the livelihoods of those people keeping them. These chickens have a multitude of functions, and these include the many cultural and traditional roles, food and income generation (Scoones 1992; Kusina and Kusina 1999). Despite their importance, productivity has been hampered by many constraints, resulting in low average flock sizes (15–20 birds) (Muchenje and Sibanda 1997; Kusina and Kusina 1999). At present, there exists a paucity of information on management

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and productivity of village chickens by farmers. The objectives of the current study were to determine (1) causes of village chicken losses as perceived by farmers, (2) how farmers control poultry diseases and (3) the level of farmers' understanding of ND.

## **Research Methodology**

### **Site**

Data were obtained from 416 rural households from Guruve District of Mashonaland, Central Province of Zimbabwe. The district is situated in a relatively dry area, receiving about 300–500 mm of rainfall per year. Agricultural production in the area comprises integrated livestock production with cotton and tobacco being the major cash crops. The area is endowed with a diversity of livestock that includes cattle, goats and poultry. Small poultry enterprises are in operation in the area (Matawo 1998).

### **Data collection**

Following research site identification, a preliminary study was conducted to establish farmer attitudes and their response to the introduction of a new project on poultry. This was conducted through the Rapid Rural Appraisal (RRA) approach. Data obtained from the random interviews with individual farmers, farmer groups, cooperatives, community leaders and rural governance were then used to develop a structured questionnaire in order to obtain quantitative data.

### **Participatory rural appraisal (PRA)**

Qualitative data were collected using Participatory Rural Appraisals (PRA) techniques. The PRA tools that were used included diagramming, scoring, ranking and calendars.

### **Baseline survey**

The information collected using the structured questionnaire included types of poultry reared, flocks size and dynamics, production levels, housing, feeds and feeding management and health management. On-farm (site) observations on other aspects of production such as housing, feeding, feed and water availability were made and data recorded by research assistants or enumerators. Details on the latter are reported elsewhere (Kusina and Kusina 1999).

### **Workshop**

Additional information was gathered from farmer representatives and other interested groups on constraints and targets for future activities. Possible approaches to address the constraints of poultry production were the major issues discussed. Participants

were separated into five mixed groups of men and women and each group was tasked with the need to generate information as advisory recommendations on first, the current situation of poultry production in the communal area of study. Second, they were asked to suggest a way forward to confront problems associated with poultry diseases and other causes of losses. In addition, participants were requested to deliberate on issues of feeds and feeding, management and marketing of poultry, as well as farmer training needs in poultry production as reported earlier by Kusina and Kusina (1999).

### **Data analysis**

Qualitative data were transformed into pie charts and bar graphs to give a pictorial representation of the findings of the study. Quantitative data were analysed using the Statistical Package for Social Sciences (SPSS, 1997) to depict descriptive statistics.

## **Results and Discussion**

### **Types of poultry and flock sizes**

Various types of poultry were found with indigenous chickens being the most predominant, accounting for 68% of all types of poultry kept by the households in the study area. The finding that indigenous chickens were the most predominant type of poultry clearly indicates that they were the most important type of poultry in the study area. This was not surprising in view of the fact that, compared to broilers and exotic layers, indigenous chickens require and are given very little expert care or any form of management. Their inherent ability to scavenge makes them the 'ideal' poultry to keep under rural management, where livestock and people often compete for food, such as cereals. Also, they are utilised for a variety of social and cultural purposes that are important in the lives of rural people (Scoones 1992; Kusina and Kusina 1999).

### **Flock composition, dynamics and productivity**

Information on flock composition, dynamics and productivity is presented in Table 1. It is important to emphasise the fact that due to the absence of previous information in the form of records on purchases, sales, slaughters and mortality, among other things, data presented on dynamics has to be taken with caution. Nonetheless, in relation to productivity, farmers indicated that on average, the indigenous chickens laid three clutches of eggs per year, each with a mean of 14 eggs. Hatchability of the eggs was high averaging, 82 % and chick survivability averaged 70% (Table 2). Despite the

purported high survivability of the chicks from the formal survey, PRA information did not corroborate such high survivability. Further, the relatively high hatchability and survivability performance recorded in this study does not agree with those reported in other studies. For example, Kitalyi (1998) reported lower hatchability in studies of village chickens in a number of African countries. The reason for the differences between this study and some reported literature might be the time when the project was conducted. This study was conducted during the winter months of June to August and during this time, hatchability and survivability of poultry tend to be higher than the rest of the year.

**Table 1.** Flock composition and productivity of the indigenous chickens.

Characteristics	Mean	Standard deviation
Flock size	15	14.6
Male chickens	2	2.3
Female chickens	12	14.2
Chicks	9	12.8
Number of clutches per year	3	0.6
Number of eggs per clutch	14	3.0
Hatchability (%)	82	13.0
Survivability (%)	70	20.0

Total number of respondents: 416

**Table 2.** Pattern of seasonal losses of indigenous chickens.

Season	Number	Per cent
Hot dry season	158	47
Hot rainy season	97	29
Cold season	73	22
All year round	7	2

Number of respondents: 335

### Mortality and causes of poultry losses

Notwithstanding the purported high survivability mentioned above, farmers confirmed that they experienced losses in their chickens as illustrated in Figure 1. Basically, losses were due to diseases, parasites and predators. The extent and severity of losses were reported to be seasonal (Table 2) with the greatest magnitude of losses (47%) occurring during the hot, dry season. In addition, losses or mortality were highest in chicks, particularly during the first 3 weeks after hatching.

When looking at Figure 1, the central circle represents all poultry losses in the area. The area covering a problem or cause of loss and the distance from the

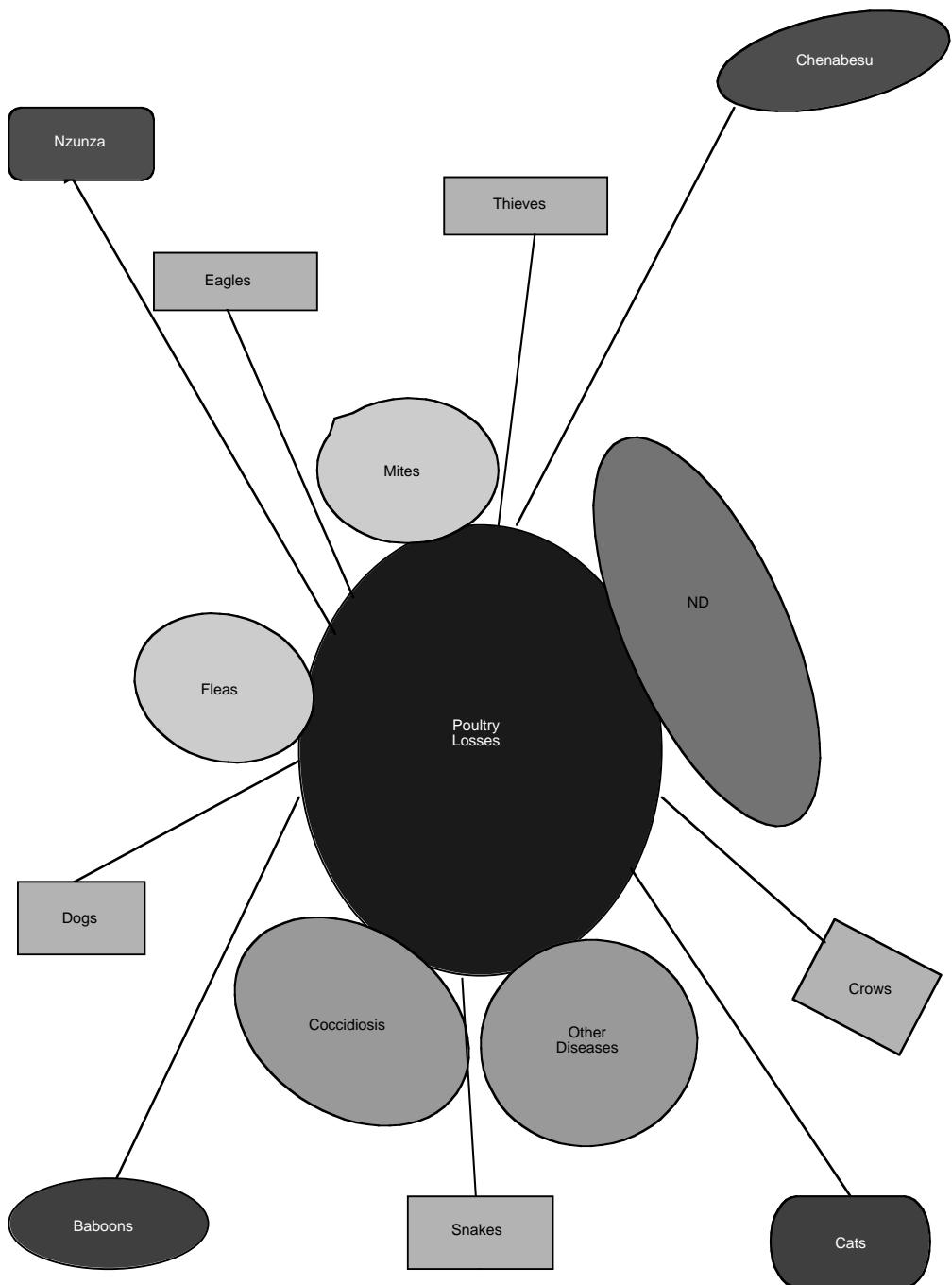
centre indicates the ease with which poultry can be lost through that particular cause. The smaller the area and the further it is away from the centre, the less important the problem is as a cause of poultry loss. In view of that, it is evident that ND is depicted as the biggest cause of poultry loss in the diagram. In addition to the data presented in Figure 1, other causes of poultry losses identified were exposure to heat and cold. The extent to which heat and cold contributed to losses as compared to diseases and other problems is depicted in Figure 2. Losses due to adverse effects of heat predominated and were higher than losses from disease. This response is because of the fact that heat will cause many chicks to die at the same time while diseases such as ND can be prevented and others can be treated. This loss may be seasonal but this is where management is crucial, for example, provision of water is very important in combating effects of heat stress. Also, appropriate housing to provide adequate ventilation can help in reducing the effects of heat stress in chickens.

The effect of cold was less severe than that of heat and diseases. Farmers, even in the rural areas, have ways of keeping chicks warm during the cold season, for example, placing chickens in boxes and housing them in their kitchens where it is warm overnight.

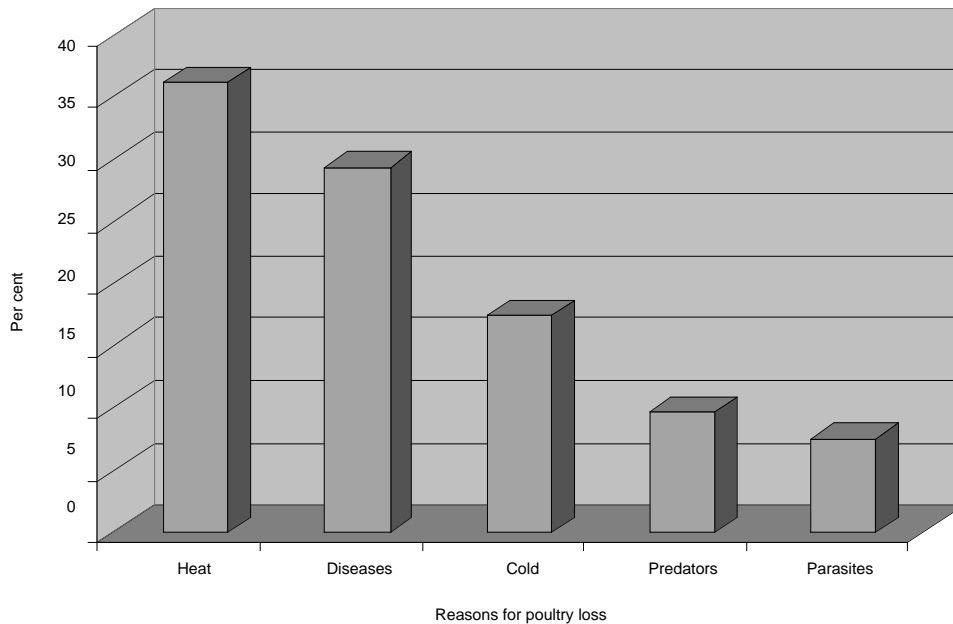
### Diseases

Newcastle disease was presented as the major cause of poultry loss by most of the farmers. This situation prevails in many other African countries (Chabeuf 1990; Kitalyi 1998). Data from Yongolo (1996) on village poultry studies conducted in Tanzania support the argument that ND is the most devastating disease of village chickens. Similarly, farmers agreed that although the disease was not endemic, it was becoming the biggest problem since it was now occurring more often than in the past (once every two years) and wipes out the whole flock when there is an outbreak. Also, farmers were aware of ND outbreaks and consequences of the disease through the media and press as well as through local knowledge. Thirty-nine percent of the farmers confirmed that their poultry flocks had been affected by ND in recent years. The extent of poultry losses from the ND outbreaks were variable. Fifty-five percent of respondent farmers indicated losses exceeding 50% of the flock.

To confirm whether farmers were familiar with ND, they were asked to describe the clinical signs of the disease. It was noted that the majority of the farmers (>80%) were familiar with the signs of the disease. Some of the signs described by the farmers were greenish diarrhoea, swelling of the neck and



**Figure 1.** Venn Diagram showing causes of poultry losses.



**Figure 2.** Causes of poultry loss according to farmers.

head, sudden death with no clinical signs, and nervous signs, for example, tremors, convulsions and paralysis of legs and wings.

Farmers were asked to disclose traditional means of treating ND. Their responses were that they did not have a treatment regime specific for ND but rather for most poultry diseases. Some of these local or traditional methods of treatment were mixing of various substances with drinking water, for example, chimney soot, washing detergent, extractions of cactus species, pepper and chillies and other herbs. The dosages of these types of treatments were not controlled and their effectiveness still remains debatable. It was also noted that farmers were aware of how the disease was transmitted to their flocks, for example, introduction of new birds into their flocks through acceptance of gifts from their relatives or purchasing of birds for breeding from other places. This observation is supported by evidence from Martin (1992) who reported that the main form of transmission of ND was through bird-to-bird contact. This was exacerbated by the fact that farmers did not have any solutions to this problem citing that it was socially unacceptable to refuse gifts from their relatives and friends. They indicated that they either sold or slaughtered sick birds before they died so that they could salvage some value out of the birds.

Other modes of ND transmission include exposure to wild birds and the existence of various age groups

of birds in the flock. This problem arises from the fact that vaccination of a flock today does not protect the hatchlings from the next brood. Invariably the newly hatched chicks are susceptible to the disease (Olabode et al. 1992).

In Zimbabwe, under the Animal Health Regulation of 1996, ND is scheduled a notifiable disease and in the face of a ND outbreak, the Government Veterinary Services are notified and normal practice dictates that all poultry in the area be vaccinated. In fact, more than 50% of the farmers in the survey acknowledged having had their poultry vaccinated while others were sceptical about the whole exercise. However, above 80% of the respondents indicated willingness to have their poultry vaccinated against ND in the event that an outbreak occurs. They also emphasised the need for speedy reaction control measures to be put in place to combat any further outbreaks and minimise their losses. Lack of strategic ND control measures in village chickens has a major adverse impact on the national poultry industry. In the event of an outbreak in communal areas and with no intervention immediately instituted, this exposes the commercial poultry industry to the disease and has a negative impact on the export of both commercial chickens and ostrich. Village chickens that survive epizootics often harbour or act as reservoirs of the virus and are often suspected as possible sources of the virus in the

commercial sector (Spradbrow 1993–1994). Other diseases identified by farmers but not shown in Figure 1 are fowl pox and fowl cholera and suspected infectious bursal disease (IBD).

Another disease that was identified as a major cause of poultry loss was coccidiosis that was said to occur often during winter. Participants however indicated that coccidiosis was less devastating than ND as it was curable. The disease only becomes a serious problem when people fail to buy the drugs that are required. Inability to procure necessary veterinary supplies was due to the cost of the drugs and the considerable distance to sources of the supplies. Although this could not be verified, some farmers purportedly used local herbal medicines for treatment of various poultry diseases.

### **External parasites**

In addition to diseases, a number of external parasites mainly, fleas and mites, were identified as contributing to poultry losses. Among the adverse effects of these parasites on poultry production were associated with a reduction in growth rates of poultry through irritation. Some suck blood resulting in anaemia and others cause hens to abandon brooding that results in poor hatchability. The parasites were very common in most poultry houses particularly during the hot rainy season. The ectoparasites also kill chicks. These were however not considered as a major problem since they could be prevented simply through improvement in housing design to ensure proper ventilation and avoid moist conditions in poultry houses. Further hygienic standards are absolutely essential to provide a clean environment in the poultry houses. Farmers indicated that they sometimes spray the chicken houses with insecticides or use traditional medicines to reduce pests.

### **Predators**

Another cause of poultry losses was a variety of predators. Although a number were identified, they were generally classified as a minor problem. These included cats, baboons, monkeys, dogs, hawks, eagles, crows, and thieves (Figure 1).

### **Seasonal patterns of poultry losses**

Seasonal calendars were developed to show the severity of losses throughout the year. As mentioned earlier, most losses occurred during the dry hot season. The farmers attributed these losses to the effects of heat and inadequate nutrition for the birds (Table 2). Similarly, the problem of predators was also seasonal. According to the data obtained, there were some specific diseases, predators and pests that were common during particular times of the year.

There were more diseases as well as predators in the dry season. Farmers highlighted that, in addition to heat, other contributory factors to the high losses were poor housing and nutrition.

Predators were noted to be a menace during the dry season. During this period, the problem of predators was twofold. First, the shortage of natural foods for baboons and other predators force them to forage as close to the homesteads as possible. Second, the vegetation cover declines substantially during the dry season. This leaves chickens, especially chicks, exposed to airborne predators such as hawks and eagles. In contrast, good vegetation cover during the wet season provides some form of protection for poultry against flying predators. Human predators (thieves) have also been identified as contributing to poultry losses.

### **Other causes of mortality**

Other causes of mortality that were not so obvious to the farmers were poor management practices, nutrition and housing of the village chickens. Although farmers know the importance of chickens in their livelihoods, they do not attach a high monetary value to the chickens. Because of this, village chickens are left to fend for themselves in every possible way. This lack of attention contributes to very high losses especially during the chick stage.

### *Nutrition*

The major feed resource base for rural poultry is scavenging and it consists of anything edible found within the environment. This scavenging feed resource base (SFRB) can include household waste, grains, worms and insects, grasses and many more. The SFRB is not constant but changes with season and household farming activities, for example, sowing and harvesting. According to Tadelles (1996), protein supply may be critical, particularly during the drier months of the year, whereas energy may be critical during the rainy season. To improve the nutrition of village chickens, and hence productivity, supplementary feeding may be necessary as this will reduce pressure on the available SFRB. This will increase the biomass that can be supported by the system, reduce survival pressure and selection against the weakest members of the flock and hence reduce mortality of chickens due lack of adequate nutrition. Lack of adequate nutrition predisposes chickens to the effects of diseases. Farmers interviewed in the survey realised the benefits of supplementary feeding to their poultry. To this end, they use a diversity of household farm produce and kitchen waste to provide supplementary feeding for their poultry. For example, the most commonly used

supplementary feeds include maize, sunflower seed meal, sorghum, finger millet, and kitchen leftovers. The majority of respondents (67%) acknowledged using crushed maize as a supplementary ration for poultry. Frequency of feeding and amounts were variable and depended on seasonal supply and fluctuation in local feed resources such as cereal grains. In addition, poultry feed is expensive for the rural resource-poor farmers to purchase (ARC 1999). That being the case, it is important to develop feeds based on locally available ingredients to supplement the SFRB of rural chickens.

### *Housing*

Good housing is a prerequisite for any viable and sustainable poultry project. In response to a question on where poultry are kept during the day and at night, all households acknowledged that exotic chickens are kept in fowl runs, both during the day and at night. Conversely, indigenous chickens and all other kinds of poultry were released to scavenge during the day and either enclosed or left in the open at night. It was also observed that 95% of the households kept their indigenous chickens in 'poor' fowl runs at night, while 3% left them to stay in trees or in open spaces. A small proportion (2%) of the households acknowledged keeping laying indigenous chickens in woven baskets at night.

Experience with rural poultry work currently running in Sanyati District of Mashonaland West Province highlighted the need for decent housing for poultry as a strategy to reduce losses, particularly from predators. In this situation, the chickens have minimal protection as some of them roost in trees at night. Chicks are exposed to predatory birds such as eagles and hawks. Snakes prey on hens roosting or nesting in baskets outside the fowl runs. This situation can, therefore, be managed through construction of proper housing using resources available in the community.

The most common type of housing observed in the study area is a raised structure made from locally available materials such as wood, thatch, bricks and sometimes scrap metal. The structure is constructed in such a way that there are a number of units used for different purposes, including keeping chickens at night and for laying chickens. Although there was some type of housing, this was generally inadequate and inappropriate. The lack of adequate housing can partly explain poultry losses/mortality. It is known that lack of proper shelter for the chickens immediately after hatching results in high mortality, as the chicks are exposed to vagaries of nature and are a prime target for carnivores such as birds, dogs, cats and reptiles such as snakes. The chicks are most

vulnerable during the first few weeks after hatching. A slight change in management techniques can reduce this kind of loss substantially, for example, provision of a wire mesh cage with adequate ventilation and drainage, at least for the first 4–5 weeks after hatching. This would reduce chick losses and substantially improve survivability of the chicks, and eventually increase the output of eggs and meat. This can be achieved with minimal inputs of feed and water provision and a modest fowl run which is kept clean to prevent diseases. Disease is a major problem and can be exacerbated by the presence of external parasites such as fleas and mites, which can proliferate under poor housing conditions. Farmers should ensure that cleaning of fowl runs is done as regularly as possible. In addition, the type of poultry housing will dictate the cleaning frequency required. Poor housing facilities were observed during the exercise and farmers requested an affordable housing design to be put in place. If this occurs, it would be ideal if most of the resources utilised are from the community.

### **Conclusion**

The major finding of the study was that the households had small flock sizes and diseases and predators reduced productivity of these flocks. ND was identified and accepted as the greatest danger to the expansion of poultry production. There is need for intervention in diseases and predator control. Control of diseases can be achieved through improvement in veterinary and advisory services. To this end, veterinary drugs should be made available and affordable in the vicinity of the participating groups of farmers to allow for immediate reaction to a disease outbreak. The problem of predators dictates that 'predator proof' housing such as wire gauze fencing and roofing can help to reduce some of the losses, especially during the night. Perhaps to prevent daylight predation, darker breeds of chickens such as those found in rural areas that are not easily identified by predators should be encouraged. Also, chicks need to stay in protected areas for the first 4–5 weeks of life as a way to avoid predators and accidents. Protection of chicks in the early days after hatching is critical, as this is the time when they are most vulnerable to predators.

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