Phase 3 – Supporting food security and capacity building in African Union member states through the sustainable control of Newcastle disease in village chickens

Proceedings
Newcastle Disease Coordination Meeting
Addis Ababa, Ethiopia
3-4 July 2013
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FOREWORD

Agriculture is essential for Africa’s social-economic development and contributes towards achieving the Millennium Development Goals. That is why agriculture stands out as strategic priority No.2 in the AU Strategic Plan 2014-2017 and, indeed, the Malabo Declaration on Accelerated African Agricultural Growth and Transformation is part of the Africa Agenda 2063. Livestock can be cited as one of the most essential assets for rural communities in African countries. However, the presence of several animal diseases, amongst other constraints, has hampered the continent from increasing productivity, feeding its population and increasing economic growth. The poultry sector is among those affected by infectious disease outbreaks. One of the diseases identified as a major constraint to the development of rural poultry production is Newcastle disease (ND).

Cognizant of this fact, the African Union Pan African Veterinary Vaccines Centre (AU-PANVAC) together with African Union Inter-African Bureau for Animal Resources (AU-IBAR) agreed to partner with the KYEEMA Foundation to implement the design phase of the project “Supporting food security and capacity building in African Union member states through the sustainable control of Newcastle disease in village chickens” with generous financial support from the Australian Government.

This ND coordination meeting launched the project. The presentations demonstrate the impact of ND in Africa and the commitment of the different AU Member States to mitigating the problem.

I believe that the project will have a significant impact on Africa’s pursuit for Food and Nutrition Security.

Tumusiime Rhoda Peace  
Commissioner for Rural Economy and Agriculture  
African Union Commission
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EXECUTIVE SUMMARY

The Coordination meeting of the pilot project ‘Supporting food security and capacity building in African Union member states through the sustainable control of Newcastle disease in village chickens’ jointly organised by the African Union Commission (AUC), the Australian Government, the International Rural Poultry Centre and the KYEEMA Foundation, was held on Wednesday 3 July 2013 at the AU headquarters in Addis Ababa Ethiopia.

The meeting was attended by the Directors of veterinary vaccine production laboratories from Africa; Representatives of AU-IBAR, OIE, FAO, GALVmed and ILRI.

The opening ceremony was graced by H.E. Ms. Lisa Filipetto the Australian Ambassador to the AU; Dr. Abebe Hailegabriel, Director, Rural Economy and Agriculture, AUC, Dr. Modibo Traore, the FAO Representative to AUC and ECA, Dr. Yacouba Samake the World Organisation for Animal Health (OIE) Regional Representative for Africa and Associate Professor Robyn Alders from KYEEMA Foundation.

During the two-day coordination meeting presentations were made on Newcastle disease (ND) and current control strategies; the socio-economic impact of ND; quality assurance of ND vaccines, vaccination strategies; ND situation in Africa and ND surveillance activities.

The participants expressed their gratitude to The Australian Government for funding the project, and acknowledged AU-PANVAC as a critical organisation of the African Union. AU-PANVAC’s key role in guaranteeing the availability of safe, potent and efficacious ND vaccines produced or imported into Africa was recognised.

The participants identified the event as a key step towards the control of ND in village chickens in AU Member States and made the following key recommendations:

- To study the socio-economic impact of ND control and how the control program could improve household food and nutrition security and stimulate improved disease reporting from the field
- To improve the surveillance, diagnosis and reporting of ND outbreaks
- To ensure the standardisation and harmonisation of locally produced vaccine
- To ensure the certification of imported and locally produced vaccines by AU-PANVAC and involve AU-PANVAC in the national registration process
- To encourage appropriate research including into reliable rapid test(s) for Newcastle disease virus
- To develop a program that will facilitate the effective and efficient control of ND at national, regional and continental levels
- Need to increase the production, sustainable distribution and use of I-2 ND vaccine for village chickens to achieve effective control of ND
- To encourage continued collaboration among participants and relevant institutions for improved coordination of ND control
- To fast track the establishment of the Pan-African Medicines Agency
- To encourage member states to fund vaccine research activities and
- To strengthen the capacity of AU-PANVAC to carry out its vaccine quality assurance activities.
ACKNOWLEDGEMENTS

We wish to express our appreciation to the African Union Commission for hosting the meeting. We would particularly like to thank Dr. Abebe Haile Gabriel, Director, Department of Rural Economy and Agriculture, AUC for chairing the meeting. We would also like to appreciate Ms. Lisa Filipetto the Australian Ambassador to the AU for gracing the occasion. Our thanks goes to Dr. Modibo Traore, the FAO Representative to AUC and ECA; and Dr. Yacouba Samake the World Organisation for Animal Health (OIE), Regional Representative for Africa for their participation in the meeting.

We would like to thank the participants for their various contributions to the control of Newcastle disease in Africa.

Finally we would like to acknowledge Drs Margaret Hogan and Mary Young for the editorial work on the book of proceedings, Associate Prof. Robyn Alders, Drs. Karim Tounkara, Nick Nwankpa and Rosa Costa, for reviewing the manuscripts, Mr. Abreham Meshesha for handling all financial issues related to the meeting, Ms. Hirut Nolawi for the secretarial work and Mrs. Bethelehem Zewde for coordinating the activities. Our most sincere appreciation goes to Emeritus Professor Peter Spradbrow of the KYEEMA Foundation for undertaking a long journey to honour the meeting and his wonderful contributions to the meeting.

We wish to acknowledge the support of the Australian Government in funding the workshop and AU-PANVAC for covering the printing cost.
ABBREVIATIONS AND ACRONYMS

ACIAR    Australian Centre for International Agricultural Research
APMV     avian paramyxovirus
AU       African Union
AUC      African Union Commission
AU-IBAR  African Union Inter-african Bureau for Animal Resources
AU-PANVAC African Union Pan African Veterinary Vaccine Centre
EID_{50} 50% embryo infectious dose
ELISA    enzyme-linked immunosorbent assay
FAO      Food and Agriculture Organization of the United Nations
GALVmed  Global Alliance for Livestock Veterinary Medicine
HI       haemagglutination inhibition
HPAI     highly pathogenic avian influenza
I-2      thermotolerant, live, avirulent ND vaccine
ICPI     intracerebral pathogenicity index
ILRI     International Livestock Research Institute
MDT      Mean death time
ND       Newcastle disease
NDV      Newcastle disease virus
NGO      Non-government organisation
OIE      World Organisation for Animal Health
PCR      polymerase chain reaction
QA       Quality assurance
REC      Regional Economic Community
RT-PCR   reverse transcription polymerase chain reaction
SPF      specific pathogen free
vNDV    Virulent Newcastle disease virus
BACKGROUND INFORMATION

Overview of Newcastle disease and current control strategies
Professor Peter Spradbrow
KYEEMA Foundation
Brisbane

Introduction
I think I am older than anyone else here and I am a card-carrying virologist of the old school. I graduated from veterinary school just as modern virology was being established. Cell culture was being introduced into a world with relatively few known viruses and no means to study viruses except in the normal hosts or in embryonated eggs. Viruses could now be recovered from defined and undefined diseases. They needed to be named, described, and classified. New journals were required for this new science. The veterinary schools and the government research laboratories of the world were setting up new virology laboratories. The one at the University of Queensland came to me.

Newcastle disease in commercial chickens
I have worked with many viruses in many species of host. Newcastle disease virus (NDV) in domestic chickens has been of special interest. Australia had been free of Newcastle disease (ND) for most of my early years as a virologist. Strict quarantine laws kept out field virus and, to the dismay of the commercial industry, the importation of vaccine was also illegal. Then an unusual, avirulent strain of NDV, called V4 was isolated in Brisbane. V4 also had unusual heat tolerance. The world changed. We could investigate this endemic virus as a possible vaccine for our commercial industry. My laboratory contributed to these studies. We had no challenge viruses but we could do this work in Malaysia where I also saw village chickens, and clinical ND, for the first time. V4 proved to be an effective vaccine.

May I offer my minority opinion on the official definition of ND? I have always taught my students that infection is the presence of a micro-organism in a host. Infectious disease is a harmful response in the host. The official definition makes no mention of sick or dead chickens - just the presence of a virus with certain laboratory characteristics. The virus has a certain sequence of nucleotides at the cleavage site of the fusion protein - no mention of what the virus does to chickens. The old school virologists believe, with Sir Macfarlane Burnett, that the significant character of a virus is its ability to cause disease and all else is secondary. Dr Simon, who also wrote on these matters might have said of these sequences that they were a necessary, but not necessarily a sufficient determinant of disease.

The other character the virus may have to be a cause of ND is a high intracerebral pathogenicity index (ICPI). This test involves the intracerebral inoculation of the virus in one-day-old specific pathogen free (SPF) chicks. The test is volumetric, the size of the inoculum is specified. But Cedric Mims showed decades ago that there is no spare space in the cranium. The inoculation requires high pressure, the virus is deposited only along the needle track and the excess flows out, or the venous plexus breaks and a crude intravenous inoculation is achieved. Surely by now we could devise a kinder method of detecting virus receptors for avian nerve cells. Has anyone an unemployed PhD student?

Here is a consequence of the definition. If I owned those hens I would rather have them alive.
ND in village chickens

In 1984 ACIAR (the Australian Centre for International Agricultural Research) was formed. Its function was to facilitate and fund cooperative research between laboratories in Australia and those in developing countries. Scavenging village chickens were starting to attract scientific attention in Asia and Africa. The ubiquitous small flocks had the potential to provide food and income for the women who owned them. They were poorly productive for a variety of reasons including ND. My Malaysian colleague Professor Latif Ibrahim and I were well placed to apply to ACIAR for a project to produce a vaccine for use in village flocks. Commercial vaccines were not suited for village use because of their 1000 dose format, their cost and mainly because of their thermolability. We had worked together with V4 vaccine in Australian commercial chickens. We were fortunate to receive funding and to have ACIAR’s Dr John Copland as our coordinator.

V4 vaccine

We used experimental V4 vaccines from various sources. Some came from our own laboratories and some were part of commercialisation studies being undertaken by companies in Australia and Malaysia. The various V4 vaccines were found to be avirulent, antigenic, protective when given by any routine method or when provided on feed to unhoused village chickens. Some of the master seeds had been selected for enhanced heat resistance. The vaccine could also spread from vaccinated chickens to unvaccinated chickens in direct contact.

The success of various trials led to V4 being registered by a commercial company and held for part of a shelf life for the Australian industry. The vaccine was then sold overseas and other companies went into production. With the various master seeds under commercial control there was no future in our plans for local production of V4 as a village vaccine.

I-2 vaccine

We suggested to ACIAR that an attempt should be made to produce a vaccine with properties similar to V4 but specifically for local production and use in village flocks. The vaccine would be kept in the public domain and the master seed made available without cost to countries wishing to make and test the vaccine. I-2 proved to be very similar to V4. It was protective even when it spread between chickens. It was thermotolerant and it caused no clinical signs, even at very high dose in one-day-old chicks. Efficacy and safety have now been demonstrated in many countries in Asia and Africa and the future use of this vaccine in Africa is a topic of the present meeting.

Routes of vaccination

We need to discuss routes of vaccination and some other practicalities. Eye-drop has given the best results but some still favour food vaccination. We started the project with food vaccination in Malaysia when chickens were rarely housed and could not be caught easily for conventional vaccination. We need the right feeds. Many seem to be hostile to the virus. I still see a future for vaccine mixed with feed in the village. There will always be inequalities in intake but natural spread of the virus should compensate for these. The use of vaccine pellets containing a chicken dose is more problematic. They will need to be diluted in feed and unequal intake will be a problem.

Timing of vaccination and duration of protection

In family flocks we have tended to vaccinate every 3 or 4 months. This has resulted sometimes in the belief that this is the duration of immunity after vaccination. I have advised frequent vaccination because of the population dynamics of village flocks. New hatchlings are constantly produced. These become susceptible to ND after they lose their maternal immunity at 1 or 2 weeks. Consider a village flock that is vaccinated but once a year. Most of the vaccinated growers will have been sold or eaten after 6 months.
The breeding hens will have produced 2 or more clutches of chickens and some of their progeny will have produced chicks. The only chickens in the flock that have been vaccinated will be the few old breeding birds.

One question to ask is 'is the average age of the chickens in a village flock?' Studies are hard to find. Consensus favours an age of about maturity. Such data should be obtained to guide us in setting guidelines for longevity of protection.

The original results from the UK in 1974 seem to hold up well in the field. The titre for haemagglutination inhibition (HI) antibody of 1 in 8 equates with protection against lethal challenge. The perception has arisen that lower titres are an indication of susceptibility on challenge. This is not a valid argument. Some chickens with low levels of antibody do survive contact challenge, especially after food vaccination.

**Local production**

Latif and I had a vision of local production of vaccine, almost a cottage industry. Vaccine production was not well regulated in those days, even in my country. But read the regulations today, especially on SPF substrates and Good Manufacturing Practice (GMP). SPF eggs are very expensive and often in short supply. I see them being lost to the poultry industry if it is ever decided that human egg-based vaccines should be made in SPF eggs. Using eggs from a local healthy flock should not introduce any exotic pathogens. The thermotolerant viruses rarely kill embryos so harvesting only live embryos should exclude the major pathogens that do kill embryos. External quality assurance will be a benefit.

There is now a move to produce I-2 vaccine in a few large regional laboratories for distribution outside the country producing the vaccine. I see merit in this. There is a need for a source of these vaccines for countries that do not have the facilities or inclination to produce their own. Production in more elaborate facilities should result in conditions of manufacture closer to official GMP.

Another rule I would like to see altered is the limit of one passage between master seed and vaccine. Vaccines are produced to a seed lot system that limits the chance of genetic variation by limiting the numbers of replication cycles. The limit for ND is very restrictive. Another passage would allow the production of much larger quantities of vaccine from the limited volume of master seed. We know that I-2 can undergo five passages without heat selection before the thermotolerance is compromised. Websters in Australia allowed four intervening passages in their production of V4. Even more passages are allowed in producing fowlpox vaccine.

I would not like to see the national production units close with the advent of the few larger producers. In the interests of competition and maintenance of skills I support the parallel systems. I suggest that the well-equipped large producers supply working seed as well as vaccine. Maintenance of seed material in the poorer laboratories is a major problem.

**Vaccines and vaccination**

I have spoken mainly of vaccines, a natural virological bias. Making vaccines and doing the evaluation experiments was easy. It is one of the few useful things a virologist can do. I often repeat to myself a few words whose origin I forget.

**Vaccines do NOT prevent disease: vaccination does.**

The heavy lifting - getting the vaccine sustainably into chickens - has been done by Robyn Alders and her colleagues. There have been the complexities of changing official attitudes, developing extension
strategies where there have been few that target village women and their poultry, organising cost recovery, 
training at many levels and assuring quality vaccines.

Some events stay long in the memory. I particularly remember a vaccination morning that Robyn Alders 
took me to in a village in Mozambique. For the first time I saw villagers paying small amounts of money 
to have their chickens vaccinated. Their appraisal of the value of their chickens was changing. Those few 
coins changing hands convinced me that our project was successful.

Help
Before concluding could I ask you for your help? A retirement task, self-inflicted, has been to write a 
review of the thermotolerant vaccines, especially I-2. It is nearly complete for the 20 or so countries that 
have written on the vaccine. I may have missed references, especially if they are in internet journals. If 
anyone has recent publications that I may have missed please let me know. Even more countries had 
been involved in the early studies on V4.

My other concern is with fowlpox. It has been my belief since our first studies in Malaysia that as ND 
is controlled the next virological problem in family flocks will be fowlpox. I believe similar forecasts are 
made in Africa. With ND whenever we approach a new country we ask
  • are village chickens important?
  • is ND a problem?
If the answers are no we go away.

Before formal surveys are undertaken could I ask your opinion on
  Is fowlpox the next important viral disease for rural poultry?
  Should a village vaccine be investigated?

Corporate affairs
I have spoken only of vaccines and vaccination, as these have been my major interest. These topics being 
of major interest to most of the participants occupy most of our meeting. We must not forget the 
organisations that make our work possible. They plan, coordinate, evaluate, organise workshops and 
finance. Our work is made possible by ACIAR, The Australian Government, GALVmed, FAO, 
KYEEMA, AU and similar groups. We are more productive when we work together.

Conclusion
It is now 30 years since Professor Latif, from Malaysia, Dr John Copland and I prepared our first 
application to ACIAR. Our naive assumption was that a special village vaccine would be required for only 
a short time, until poverty was reduced in rural areas and villagers could afford commercial vaccines. ND 
continues to be a major constraint to the productivity of family flocks. Poverty persists but we do have 
appropriate vaccines. We have tried to keep the vaccine as cheap as possible. No patents, the master seed 
in the public domain and freely available, no attempt to make any great profit from the rural poor. My 
worry is that a vaccine produced commercially may be more expensive.

We have the vaccines. In the laboratory they give splendid results. We may not be able to match these 
exactly in the field. Field vaccination is more difficult and record taking is not as precise. We can expect 
substantial protection.

Until infrastructure is greatly improved, the thermotolerance aspect of the vaccine is essential. I-2 has this 
property and the heat-resistant variant of V4 is still produced by one company. 
We can make I-2 in large quantities in a few commercial laboratories and in smaller quantities in national 
laboratories, subject to quality assurance.
We can make a greater difference if we can greatly increase vaccine coverage. This will need a mixture of expertise – making vaccine, vaccination, designing and implementing extension programs, regulation and assessment.

I still see the need for some research – food vaccination, increasing thermotolerance, intense activity on the biological nature of village chicken flocks, especially age structure, and long-term performance of the vaccine.

There are some 40 of us here. There are more than 400 million chickens waiting for us out there in this continent alone. We still have a lot to do.
Socioeconomic impact of Newcastle disease in village poultry in Africa
Rosa Costa¹, Mary Young², Robyn Alders²
¹KYEEMA Foundation, Maputo; ²KYEEMA Foundation Australia

Introduction
Free-ranging scavenging poultry are the most common form of livestock kept throughout the developing world. For the poorest households they are an important source of high-quality protein and essential micro-nutrients, and their most readily saleable asset (Copland and Alders 2005). Poultry are often owned and managed by women and children for whom they represent an important source of cash income in times of need through the sale of adult birds, chicks or eggs (Bagnol 2001).

Attaining sustainable food security and safety remains difficult while vast numbers of poultry die annually from preventable diseases such as Newcastle disease (ND), and family poultry producers remain disengaged from national animal health services. ND is currently one of the most serious epizootic poultry diseases in most poor countries (Branckaert and Guèye 1999). Occurs every year and kills on average 70 to 80% of non-immune chickens in rural communities leaving people without an important source of animal protein and income. Despite the high incidence of ND currently very few backyard or village poultry keepers in Africa vaccinate their poultry against ND or any other diseases or, provide any other inputs or management. This review paper intends to demonstrate that by decreasing mortality due to ND, smallholder farmers can increase their income and achieve significant improvements for their families and their communities and is based on work done by over the past years in Sub-Saharan Africa.

Essential components of a sustainable ND control program
Experience has shown that a sustainable ND control program is composed of five essential components: a) support and coordination by relevant government agencies for the promotion of vaccination programs; b) an appropriate vaccine and vaccine technology; c) effective extension materials and methodologies that target veterinary and extension staff, community vaccinators and farmers; d) simple evaluation and monitoring systems; and e) economic sustainability based on the commercialisation of the vaccine and vaccination services and marketing of surplus chickens; (Copland and Alders 2005).

Coordination of activities
ND control activities will have a better chance of being sustainable if all stakeholders are involved in the process from the outset with the support of senior decision makers. Possible stakeholders include: farmers, village leaders, community vaccinators, extension workers, veterinary services staff, private sector, livestock and social scientists and NGOs.

Appropriate vaccine and vaccine technology
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
- Cost
- Immunogenicity
- Transportability
- Availability.

In circumstances where the cold chain is weak or absent, the only reliable option will be the use of thermostolerant ND vaccines; maintaining the vaccine cold chain of proper refrigeration from manufacturer to the beneficiary is vital for immunisation programs and extremely challenging especially in
low resources settings. Overheating can damage the vaccine potency. Ideally the vaccine should be stored between 2-8 °C.

If a country decide to start local production of the ND vaccine it is important to conduct a risk analysis and ensure capability to produce effective vaccine with good quality and potency. This analysis should be done in sufficient detail for all stakeholders to understand the risks and benefits associated with each option.

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 a ND vaccine that is locally produced.

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. Table 1 presents the cost of the ND I-2 vaccine and vaccination per bird in selected countries in 2012.

**Table 1.** Cost of the vaccine and vaccination in some countries (I-2 ND vaccine, 2012)

<table>
<thead>
<tr>
<th>Country</th>
<th>Vaccine droppers</th>
<th>Price per bird</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Doses</td>
<td>Price</td>
</tr>
<tr>
<td>Malawi (US$1 ~ 300 MKW)</td>
<td>300</td>
<td>1100 MKW (approx. US$3.65)</td>
</tr>
<tr>
<td>Mozambique (US$1 ~ 30MZN)</td>
<td>250</td>
<td>25 MZN (approx. US$0.88)</td>
</tr>
<tr>
<td>Tanzania (US$1 ~ 1.550 TZS)</td>
<td>400</td>
<td>4000 TZS (approx. US$2.60)</td>
</tr>
<tr>
<td>Zambia (US$1 ~ 5.2 ZKW)</td>
<td>300</td>
<td>15 ZKW (approx. US$3.00)</td>
</tr>
</tbody>
</table>

**Efficient gender sensitive extension material and methodologies**
The extension program should seek to provide each group involved (from national to regional to village to household levels) in the implementation and monitoring of ND control activities with the information needed to make sound decisions and adequate plans. All involved with the work, from the decision level until the farmer, should receive information appropriate to their role to enable them to make sound decisions that will support the successful implementation of activities. A comprehensive extension package should be developed for use with all available communication options, in particular, radio, newspapers, group meetings, field days, drama, school lessons, etc.

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

In order to increase the success rate of ND control activities, adequate planning, organisation and training are prerequisites.

The necessary training will include short courses for key national and regional decision-makers, workshops for staff involved in the training of extension workers and community vaccinators, training sessions and refresher courses for front-line extension staff and community vaccinators. Components of the training should include the characteristics, handling and administration of the selected vaccine, how to organise a vaccination campaign and how to monitor progress and the identification of problems and their resolution poultry husbandry, feeding and housing.

**Monitoring and evaluation**

The use of participatory ranking and scoring methods allows qualitative indicators, often based on opinions or perceptions, to be presented and analysed numerically.

An important component of a sustainable ND control program relates specifically to the empowerment of women as the main poultry keepers, through improvements in chicken productivity achieved through reduced mortality from ND.

**Economic sustainability**

For ND control activities to be sustainable in the long term, all costs must be covered:

- production costs,
- distribution costs and
- use of the vaccine.

Commercialisation of the vaccine (~US$1.00/ 250 doses) and vaccination services (community vaccinator charges~US$0.03/ bird), and marketing of surplus birds and eggs.

**Impact of the implementation of a ND control program using I-2 ND vaccine**

ND control in village chickens can make a significant contribution to poverty alleviation. The impact of ND control on the welfare of participating farmers was measured during the project ‘Control of ND in Malawi, Mozambique, Tanzania and Zambia’. Participatory Rural Appraisal (PRA) and surveys were conducted every year in the four countries and community vaccinator records were analysed to provide information on the impact of project activities on a number of production, social and economic measures in the communities.

The questionnaires included:

- Size of flock
- Numbers of chickens and eggs sold and exchanged
- Numbers of chickens and eggs consumed by the family
- Knowledge and attitude towards vaccination
- Nutritional knowledge about chicken products
- Participation in vaccination campaigns.

Sampling procedures in each country involved: A random selection of 15 clusters across the (3-5) participating villages; a random selection of 10 households per cluster based on the available list of households, total sample size of between 139 to 160 households, sampling error: between 7.8% to 8.3% with 95% of confidence.
Participation in the I-2 ND vaccination campaigns by households

As shown in Table 2 there was a substantial increase in the proportion of households participating at least once in the ND vaccination campaigns in the target villages in all locations, from the baseline to the first follow-up survey. The increase in participation was dramatic in both districts of Mozambique and in Tanzania. Subsequent increase was gradual in both Massingir and Malawi, but in Tanzania, there was almost 100% uptake in the first follow-up survey, with maintenance of this level through to the third follow-up survey. In Chigubo, following an impressive increase through to the second follow-up survey, this fell back significantly over the following twelve months.

Table 2. Mean proportion (%) of households i) participating in the vaccination campaigns and ii) participating in the vaccination campaigns three times each year, in the baseline and subsequent surveys in the project target villages in Tanzania, Malawi and in the Chigubo and Massingir districts of Mozambique. Means within rows with different superscripts are significantly different (P<0.05).

<table>
<thead>
<tr>
<th>Location</th>
<th>Baseline</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Follow-up 3</th>
<th>Probability</th>
</tr>
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<tbody>
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<td>Baseline</td>
<td>Baseline</td>
<td>Follow-up 1</td>
<td>Follow-up 2</td>
<td>Follow-up 3</td>
<td>Probability</td>
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<td>31.0\textsuperscript{c}</td>
<td>67.9\textsuperscript{a}</td>
<td>48.8\textsuperscript{b}</td>
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<td>60.3\textsuperscript{c}</td>
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<td>99.3\textsuperscript{a}</td>
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<tr>
<td>Malawi</td>
<td>52.5\textsuperscript{c}</td>
<td>68.1\textsuperscript{a}</td>
<td>76.0\textsuperscript{a}</td>
<td>86.2\textsuperscript{a}</td>
<td>0.00</td>
</tr>
</tbody>
</table>

ii) Households participating three times per year

<table>
<thead>
<tr>
<th>Location</th>
<th>Baseline</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Follow-up 3</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique</td>
<td>0.0\textsuperscript{b}</td>
<td>2.8\textsuperscript{b}</td>
<td>11.6\textsuperscript{a}</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Chigubo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mozambique</td>
<td>14.2\textsuperscript{b}</td>
<td>34.5\textsuperscript{a}</td>
<td>-</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Massingir</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tanzania</td>
<td>-</td>
<td>96.1</td>
<td>97.5</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>Malawi</td>
<td>8.3\textsuperscript{c}</td>
<td>18.4\textsuperscript{a}</td>
<td>44.5\textsuperscript{a}</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

There was an increase over time in the proportion of households participating in three consecutive campaigns in Chigubo, Massingir and Malawi, but at significantly lower overall rates than those participating in one to three campaigns. Interestingly, there was essentially no difference between these measures for the Tanzanian households, indicating their rapid and full adoption of the recommended vaccination protocol.

Participation in the vaccination campaigns by the households, at least initially, is a good measure of the success of the sensitisisation and promotional elements of the project in the villages in the respective regions. Reasons given for the poor uptake in Chigubo include ineffective initial sensitisation and education by extension staff, the general poverty of the region resulting in a reticence to pay community vaccinators for their service, large distances between households making it difficult for the vaccinators to vaccinate a reasonable number of flocks in the one day (the 300 dose vials once opened must be used within two days), the remote location making sale of birds and eggs difficult, and the community's relatively greater reliance on other livestock and bush meat.
Household flock size
Changes over the three years of the project in the size of the household flocks in the target villages in Mozambique, Tanzania and Malawi are shown in Table 3.

Table 3. Mean household flock size in the baseline and subsequent surveys in the project target villages in Tanzania, Malawi and in the Chigubo and Massingir districts of Mozambique. Means within rows with different superscripts are significantly different (P<0.05).

<table>
<thead>
<tr>
<th>Location</th>
<th>Baseline</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Follow-up 3</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique - Chigubo</td>
<td>12.4&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>14.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.2&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>10.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.03</td>
</tr>
<tr>
<td>Mozambique - Massingir</td>
<td>10.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>17.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-</td>
<td>0.00</td>
</tr>
<tr>
<td>Tanzania</td>
<td>16.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.01</td>
</tr>
<tr>
<td>Malawi</td>
<td>8.7</td>
<td>10.4</td>
<td>11.0</td>
<td>9.9</td>
<td>0.37</td>
</tr>
</tbody>
</table>

The analysis shows a significant increase in flock size in project villages in Tanzania and in the Massingir district of Mozambique, a non-significant increase in Malawi, but an actual decrease in the Chigubo district in Mozambique.

Changes in flock size can be due to the effects of a number of factors, and an increase need not necessarily reflect improved productivity, or the reverse. As more households are encouraged by the success of others to participate in the program, it is quite likely that these later entries have smaller household flocks than those who entered the program earlier.

Total household chicken production
Table 4 shows the mean total number of birds held, consumed, sold and exchanged over the previous three months by the households in the four locations. There were moderate increases from the baseline survey in Massingir, Tanzania and Malawi, but a later significant fall in Chigubo following an initial increase.

Table 4. Mean total number of chickens held, consumed, sold and exchanged by each household over the past three months in the baseline and subsequent surveys in the project target villages in Tanzania, Malawi and in the Chigubo and Massingir districts of Mozambique. Means within rows with different superscripts are significantly different (P<0.05).

<table>
<thead>
<tr>
<th>Location</th>
<th>Baseline</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Follow-up 3</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique - Chigubo</td>
<td>16.9&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>20&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.3&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>13.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.00</td>
</tr>
<tr>
<td>Mozambique - Massingir</td>
<td>17.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
<td>0.00</td>
</tr>
<tr>
<td>Tanzania</td>
<td>25.4&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>25.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>31.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.00</td>
</tr>
<tr>
<td>Malawi</td>
<td>11.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>15.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Impact of recommended vaccination protocol on flock size
As a direct measure of the impact of the recommended vaccination protocol on flock size, mean values were determined on flock size in households which vaccinated the recommended three times per year and in those which did not vaccinate. Mean values for the two groups in Malawi and in the Chigubo and Massingir districts of Mozambique over follow-up surveys 1, 2 and 3, are shown in Table 5. Data from
Tanzania was not included as there were insufficient households which did not vaccinate, to provide a reliable mean value.

**Table 5.** The impact of three consecutive vaccinations (versus no vaccination) on mean flock size in households in the three follow-up surveys in the project target villages in Malawi and in the Chigubo and Massingir districts of Mozambique.

<table>
<thead>
<tr>
<th>Location</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Follow-up 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N.V.</td>
<td>R.V.S.</td>
<td>P</td>
</tr>
<tr>
<td>Mozambique - Chigubo</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mozambique - Massingir</td>
<td>27.0</td>
<td>29.5</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Malawi</td>
<td>10.1</td>
<td>22.3</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

N.V. No vaccination  
R.V.S. Recommended vaccination schedule: three times per year

In all but one case the data clearly shows a significant and substantial increase in flock size in the households vaccinating three times.

**Reasons for keeping chickens**
Changes over time in the reasons given by householders in the target villages for keeping chickens, can be regarded as a measure of the impact of the project. The two most common reasons provided across all villages were for home consumption or for sale. Table 6 shows the change in the proportion of households claiming that consumption or sale was their principal reason for keeping chickens, with time.

**Table 6.** Proportion (%) of households providing i) home consumption and ii) sale as the principal reason for poultry keeping in the baseline and subsequent surveys in the project target villages in Tanzania, Malawi and in the Chigubo and Massingir districts of Mozambique. Means within rows with different superscripts are significantly different (P<0.05).

**i) Home consumption**

<table>
<thead>
<tr>
<th>Location</th>
<th>Baseline</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Follow-up 3</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique - Chigubo</td>
<td>37.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>37.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.01</td>
</tr>
<tr>
<td>Mozambique - Massingir</td>
<td>19.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>34.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>34.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
<td>0.01</td>
</tr>
<tr>
<td>Tanzania</td>
<td>33.6</td>
<td>37.3</td>
<td>31.2</td>
<td>35.6</td>
<td>0.69</td>
</tr>
<tr>
<td>Malawi</td>
<td>46.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>53.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>45.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>72.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.00</td>
</tr>
</tbody>
</table>
There were no clear trends in either component in any of the locations. While there was an indication that home consumption was of increasing importance in Massingir in the first year and in Malawi in the final year, there was considerable year to year variation. In comparison to consumption, there was a commensurate reduction in the importance given to chicken sales in the first year in Massingir and in the final year in Malawi. The result in Massingir may be related to a substantial increase in household flock size over this initial period, but there was no change in flock size in Malawi between the second and third follow-up surveys.

**Bird mortality**

In the PRAs and the annual surveys, two of the data sets collected related to measures of the impact of the project on bird mortality and the role of ND in this over time. The first measure was householders’ perceptions about the main causes of bird mortality over the three years of the project, and the second was their perceptions about the impact of the vaccination program on mortality rates. The first of these data sets is shown in the below table as the proportion of households regarding ND as the main source of mortality, and the second set is shown as the proportion of households who considered that vaccination had led to a reduction in mortalities.

### Table 7. Proportion (%) of households i) who see ND as the principal cause of mortality, and ii) who believe that mortality had been reduced by ND vaccination in the project target villages in Tanzania, Malawi and in the Chigubo and Massingir districts of Mozambique. Means within rows with different superscripts are significantly different (P<0.05).

#### i) ND as the main cause of mortality

<table>
<thead>
<tr>
<th>Location</th>
<th>Baseline</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Follow-up 3</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique - Chigubo</td>
<td>73.8</td>
<td>69.5</td>
<td>62.4</td>
<td>62.8</td>
<td>0.20</td>
</tr>
<tr>
<td>Mozambique - Massingir</td>
<td>73.8a</td>
<td>53.2b</td>
<td>21.6c</td>
<td>-</td>
<td>0.00</td>
</tr>
<tr>
<td>Tanzania</td>
<td>89.0a</td>
<td>35.3b</td>
<td>11.0c</td>
<td>0.7b</td>
<td>0.00</td>
</tr>
<tr>
<td>Malawi</td>
<td>90.7a</td>
<td>67.2a</td>
<td>65.4b</td>
<td>47.2c</td>
<td>0.00</td>
</tr>
</tbody>
</table>

#### ii) Reduction in mortality

<table>
<thead>
<tr>
<th>Location</th>
<th>Baseline</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Follow-up 3</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique - Chigubo</td>
<td>0b</td>
<td>50.0a</td>
<td>77.0a</td>
<td>66.7a</td>
<td>0.00</td>
</tr>
<tr>
<td>Mozambique - Massingir</td>
<td>-</td>
<td>89.9</td>
<td>93.9</td>
<td>-</td>
<td>0.23</td>
</tr>
<tr>
<td>Tanzania</td>
<td>64.5a</td>
<td>80.7a</td>
<td>82.2a</td>
<td>90.3a</td>
<td>0.00</td>
</tr>
<tr>
<td>Malawi</td>
<td>58.7b</td>
<td>87.4a</td>
<td>89.9a</td>
<td>88.9a</td>
<td>0.00</td>
</tr>
</tbody>
</table>
With the exception of Chigubo, there was a significant reduction with time in the proportion of households in all other locations who considered ND to be the main cause of mortality. The decrease was dramatic in Tanzania where the project has obviously had a huge impact. The other perceived main causes of mortality, not shown in the table, were ‘predators’ and ‘other diseases’; the incidence of both of these increased commensurately with time in most locations. In all four locations there was a high proportion of households who considered that the vaccination program had reduced mortality rates. In nearly all cases this proportion increased with time. The positive baseline figures for Tanzania and Malawi, suggest prior exposure to vaccination in these communities. There would seem to be an anomaly between the very high proportion of households in follow-up surveys 1 and 2 in Massingir who considered that vaccination had led to a reduction in mortality, and the relatively low to moderate participation rate in the program by households in this region. In determining the factors associated with community uptake of ND control measures, the reasons behind this apparent anomaly should be investigated.

The two above sets of data clearly indicate that householders in the target villages believe that I-2 ND vaccination results in a reduction in bird mortality. The lack of actual measures of mortality levels in the household flocks, either through surveys or monitoring, however, makes it difficult to quantify the effect. It is recognised that such quantification would be difficult to determine with any accuracy, but would add considerably to the indications provided by the above measures.

Householder knowledge on vaccination recommendations

Data obtained in the PRAs and annual surveys relating to householder knowledge about the requirement to vaccinate three times per year in order to achieve effective control of ND are shown in table 8.

Table 8. Proportion (%) of households nominating a requirement to vaccinate three times per year to achieve effective control of ND in the baseline and subsequent surveys in the project target villages in Tanzania, Malawi and in the Chigubo and Massingir districts of Mozambique. Means within rows with different superscripts are significantly different (P<0.05).

<table>
<thead>
<tr>
<th>Location</th>
<th>Baseline</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Follow-up 3</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique - Chigubo</td>
<td>9.8</td>
<td>6.8</td>
<td>15.6</td>
<td>14.8</td>
<td>0.06</td>
</tr>
<tr>
<td>Mozambique - Massingir</td>
<td>8.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>12.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-</td>
<td>0.03</td>
</tr>
<tr>
<td>Tanzania</td>
<td>30.1</td>
<td>85.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>94.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>96.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.00</td>
</tr>
<tr>
<td>Malawi</td>
<td>35.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>39.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>60.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>57.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The data shows a rapid and substantial increase over time in the proportion of Tanzanian households who understood the need to vaccinate three times per year, but the rate of increase was significantly slower in Malawi, substantially slower in Massingir, and still at a very low level (15%) in households in Chigubo after three years. These figures give a good indication of the relative adoption of the ND control program by households in the four locations. This highlights the need for location specific processes and promotional tools to facilitate adoption of the recommended vaccination protocol by households.

Gender implications

Given the generally acknowledged role of women in caring for the chickens, the surprising result from the top section of the table, is the relatively low acknowledged ownership rate by women, in all locations with the possible exception of Malawi. From the PRA results, this is likely due to the cultural deference to males as the head of the household and ‘owner’ of the family’s livestock. Again, as indicated by the PRA interviews, it may not be a true reflection of decision making or even of who receives money from the
sale of birds or eggs. One aspect that should be noted, is the apparent reduction in ownership by women in Tanzania, where the project has been very successful and poultry keeping has become a financially viable enterprise.

Table 9. Proportion (%) of i) households with women as the acknowledged owner of the chickens, and ii) households which vaccinate where women are responsible for making that decision, in the project target villages in Tanzania, Malawi and in the Chigubo and Massingir districts of Mozambique. Means within rows with different superscripts are significantly different (P<0.05).

<table>
<thead>
<tr>
<th>Location</th>
<th>Baseline</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Follow-up 3</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique - Chigubo</td>
<td>-</td>
<td>26&lt;sup&gt;a&lt;/sup&gt;</td>
<td>49&lt;sup&gt;a&lt;/sup&gt;</td>
<td>44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.00</td>
</tr>
<tr>
<td>Mozambique - Massingir</td>
<td>-</td>
<td>55</td>
<td>48</td>
<td>-</td>
<td>0.07</td>
</tr>
<tr>
<td>Tanzania</td>
<td>-</td>
<td>67&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42&lt;sup&gt;a&lt;/sup&gt;</td>
<td>43&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.00</td>
</tr>
<tr>
<td>Malawi</td>
<td>-</td>
<td>58</td>
<td>65</td>
<td>59</td>
<td>0.54</td>
</tr>
</tbody>
</table>

There was no evidence of any significant time related change in the proportion of women deciding to vaccinate, in any location. What is concerning again, is the relatively low overall rate. It may, however, to some extent be a reflection again of deferential bias to the male household head in the responses, and not necessarily be an accurate indicator of who actually did make the decision. An in depth analysis of the situation in Singida, however, suggested that flock size was a determinant in the gender of the decision maker: as flock size increased, women gave way to men as the decision maker.

Impact upon household income
The PRA reports suggest a very real and positive impact of ND vaccination upon these project goals. In Singida district of Tanzania monthly income from chicken raising increased from 10,000 to 50,000 TZS between 2010 and 2012. This five-fold increase in income over two years has huge implications for the promotion of I-2 ND vaccination. The uptake of ND vaccination in the Singida district over this period was dramatic.

Conclusion
The uptake of ND vaccination varied from country to country, but the results indicate that it is reasonable to assume that ND vaccination can contribute significantly to increased income in households of smallholder farmers and significant improvements for their families and their communities.

Acknowledgements
We are grateful for the interest of all who have assisted with the implementation of the project: The Australian Government for financing most of this work, the Governments, country coordinators,
farmers and researchers of Malawi, Tanzania, Mozambique and Zambia were the activities have been implemented.

References


Laboratory diagnosis of Newcastle disease in tropical Africa

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B.P. 12 104 Dakar-Yoff Senegal

Introduction
Poultry farming is an important economic activity that includes a great number of actors. Only a few are engaged full-time and most, especially women, are engaged part-time. Poultry farming is important because of the size: there are over 800 million poultry in sub-Saharan Africa. There are two types of poultry farming: the traditional and improved systems. It is a source of animal protein with high nutritional value for the rural and peri-urban population and is an important element in the fight against poverty. However, its development is hampered due to diseases, which cause many losses in poultry farming.

Table 1. Characteristics of the two types of poultry farming

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Traditional poultry</th>
<th>Improved poultry farming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Small number</td>
<td>Dozens or hundreds</td>
</tr>
<tr>
<td>Level of inputs</td>
<td>Very low</td>
<td>Very important</td>
</tr>
<tr>
<td>Type of farming</td>
<td>Free-ranging</td>
<td>Closed</td>
</tr>
<tr>
<td>Time dedicated to the farming</td>
<td>Part-time</td>
<td>More than part-time</td>
</tr>
<tr>
<td>Type of Farmers</td>
<td>Mainly women</td>
<td>Professionals</td>
</tr>
<tr>
<td>Breeds or strain used</td>
<td>Indigenous or hybrid</td>
<td>Improved</td>
</tr>
<tr>
<td>Motivations</td>
<td>Improving daily living</td>
<td>Business which brings income</td>
</tr>
</tbody>
</table>

ND is described as the scourge of traditional poultry flocks in Africa. The mortality rate can reach 80% to 100% in unprotected flocks. In Senegal, the highest prevalence rate of ND can reach 90% (Traore 2001). Studies undertaken on ND in traditional and improved systems showed that ND remains one of the main obstacles to the development of the two types of farming (Grundler et al. 1988; Courtecuisse et al. 1990; Arbelot et al. 1997; Ichakou 2004).

This paper will describe the clinical presentation of ND, the different methods of diagnosis and the skills that the diagnostic laboratories must have in Africa.

General Information on ND
ND is a highly contagious infectious disease, affecting mainly birds (gallinaceous poultry) caused by a paramyxovirus virus (avian paramyxovirus type 1) belonging to the genus Avulavirus. We can distinguish 10 types of avian origin (APMV - Avian paramyxovirus). All the ND virus strains belong to serotype 1 (APMV -1).

The pathogenicity is daunting because the highly pathogenic viruses cause peracute disease, haemorrhagic lesions and many deaths. However, the pathogenicity is variable quantitatively (velogenic, mesogenic, lentogenic strains) and qualitatively.
Table 2. Virus characteristics and pathogenicity

<table>
<thead>
<tr>
<th>Pathogenicity</th>
<th>Disease description</th>
<th>Clinical signs and lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velogenic viscerotropic</td>
<td>Acute fatal infection</td>
<td>Hemorrhagic lesions</td>
</tr>
<tr>
<td>Velogenic neurotropic</td>
<td>Acute fatal infection and neurological signs</td>
<td>Respiratory and nervous systems affected</td>
</tr>
<tr>
<td>Mesogenic</td>
<td>Low pathogenicity</td>
<td>Respiratory and nervous systems affected</td>
</tr>
<tr>
<td>Lentogenic</td>
<td>Very low pathogenicity</td>
<td>Respiratory system affected</td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>Infection inapparent, no death</td>
<td>Lack of clinical signs and lesions</td>
</tr>
</tbody>
</table>

Quantification of the pathogenicity involves the determination of the intracerebral pathogenicity index (ICPI) in day-old chicks. ICPI higher than or equal to 0.7 characterises the mesogenic or velogenic strains. The virulence of these strains is usually determined by the presence of multiple basic amino acids at the cleavage site of the F protein.

The qualitative assessment of pathogenicity allows viscerotropic, neurotropic and pneumotropic strains to be distinguished, according to the virus tropism.

Virus antigenicity is linked to the nucleoprotein (NP antigen common to all avian paramyxoviruses) and surface glycoprotein (in particular the haemagglutinin type) antigens.

The immunogenicity demonstrated through the haemagglutination inhibition (HI) antibody allows ND virus (APMV-1) to be distinguished from other avian paramyxovirus serotypes.

**Diagnostic Laboratory**

Direct and indirect methods of diagnosis are undertaken in the laboratory. The direct virological methods are based on isolation and identification of virus from tissues collected at autopsy, tracheal, esophageal and/or cloacal swabs of live birds. These samples are minced in phosphate buffered saline. After centrifugation, the supernatants are inoculated into embryonated eggs or on cell culture (required for trade tests). A haemagglutinating virus is identified by haemagglutination of chicken red cells (HA) and the serotype by HI in the presence of reference antibody for ND or mouse monoclonal antibody.

Identification is completed with the determination of the ICPI.

ND notifiable to the OIE is defined as: an infection of birds due to an avian paramyxovirus belonging to serotype 1, and which has one of the following criteria of virulence: either an ICPI of at least 0.7 or possess multiple basic amino acids (AA) (at least three AA such as arginine -R- or K- lysine) at the C-terminus of the F2 protein and a phenylalanine at the N-terminus of the F1 protein.

Molecular techniques such as the RT - PCR and the rRT-PCR from swabs, organs or tissues are also used for virus identification.

Indirect virology methods detect antibodies which are evidence of infection through the haemagglutination reactions and haemagglutination inhibition (alternate test required for trade purposes), the serum neutralisation and different forms of ELISA (Basic ELISA, indirect, blocking or competitive).
Competency needed in the diagnostic laboratory

The diagnostic laboratory must have competent human resources in several areas (isolation, identification and ICPI) and the opportunity of periodic refresher training as well as financial autonomy.

Those requesting diagnostic services are mostly farmers with large numbers of birds (improved livestock), the government or decentralised public service, or NGOs. Generally owners of backyard poultry cannot pay the diagnostic fees and do not request the service.

Sustainability can only be met by sensitising the farmers and partners but the government also has an important role. MDT

Conclusions

1. The diagnostic laboratory is an important tool that must be used in livestock promotion to increase productivity and fight against poverty.
2. The diagnostic laboratory is an integral part of the epidemiological surveillance system, which is an ongoing activity and should not suffer from any limitation in its activities.
3. The diagnostic laboratory also plays a major role in assessing the results achieved in the fight against diseases.
4. Therefore, it is at the forefront and conclusion of all animal health processes and even public health, in the fight against poverty.

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Quality Assurance of Newcastle disease vaccines
Nick Nwankpa, Charles Bodjo and Karim Tounkara,
AU-PANVAC

Introduction
In recent years, the world has witnessed the emergence and re-emergence of major diseases of animals due to the effects of globalisation and climate change. This situation has led to increased recognition of the important role livestock plays in the lives of the poor who depend on them with estimates indicating that some 600 million people today, representing at least 70% of the world's poor depend on livestock for part or all of their livelihoods. These animal diseases have become a major threat to the livestock industry and are often considered to be the biggest constraints to improving livelihoods and resilience.

In various studies diseases have been identified as the major constraint to the development of the poultry sector where diseases such as ND, infectious bursal disease or Gumboro, Marek's disease, fowl typhoid, cholera, mycoplasmosis and coccidiosis have been identified as major constraints to production. It has however been indicated that the most devastating disease of poultry in most of Africa is ND. ND is a highly contagious and fatal disease of mostly chickens, affecting the respiratory and nervous systems. It is caused by a paramyxovirus, with the most virulent strains isolated in Africa.

Quality assurance of ND vaccine at AU-PANVAC
As for most viral diseases, vaccination remains the only suitable and effective control tool for ND. Presently several ND vaccine seeds are used to produce vaccines for the control of the disease in Africa. These include Hitchner-B1, La Sota and the I-2 vaccine strains. These vaccine seed strains are currently being distributed free of charge to all vaccine production laboratories in Africa by AU-PANVAC which is the only organisation mandated to carry out the independent quality control of all veterinary vaccines including ND vaccines either produced or imported into Africa.

Establishment of AU-PANVAC
Africa witnessed a great depression in the livestock industries in the early 1970s due to a general decline in the quality of veterinary vaccines produced, decline in the delivery capacities of diagnostic laboratories and inefficiencies or non-existence of national quality control authorities. This led to a major resurgence and spread of rinderpest in many African countries occurred in the early 1980's leading up to US$100 million in direct losses and more than US$1 billion in indirect losses.

This situation prompted the African Heads of State and Governments to set up the Pan African Rinderpest Campaign (PARC) through the Interfrican Bureau for Animal Resources of the then OAU (OAU-IBAR) with financial support from the European Union (as the largest donor) to control and ultimately eradicate rinderpest and other epidemic diseases from Africa and also to revitalise the animal health services. However in order to embark on that campaign, an audit was requested to determine the quality of vaccines used in the first campaign. The survey, which was conducted by FAO in 1983, showed serious deficits in quality of vaccines produced by the 11 vaccine producing laboratories.

In recognition of the importance of good quality vaccines in the rinderpest eradication campaign, the FAO Expert Consultation on rinderpest held in Rome in October 1984, urged all vaccine producing laboratories to participate in the implementation of an International and Independent vaccine quality control scheme. The FAO in response to this recommendation established two Regional Vaccine Quality Control and Training Centres as they were then known in 1986, with one located in Debre Zeit (Ethiopia) and the other in Dakar (Senegal), through its Technical Cooperation Program (TCP/RAF/6767 and 6766) dedicated to improving the quality of the rinderpest vaccine produced in Africa. This initiative was followed by UNDP funding (UNDP/RAF/88/050) under the responsibility of
the OAU-IBAR, with FAO as the executing agency in 1989. By 1993 it became necessary to merge the two units into one centre which was renamed ‘the Pan African Veterinary Vaccine Centre (PANVAC)’ located in Debre Zeit (Ethiopia).

Encouraged by the performance of PANVAC, the 4th Conference of African Ministers responsible for Animal Resources held in Addis Ababa, Ethiopia between the 11 and 15 April 1994 recommended the institutionalisation of PANVAC as a technical centre of the then OAU.

By February 1998, the 67th ordinary session of the then OAU council of Ministers held Addis Ababa, recognising the importance of livestock production to the African economy and the significant role of PANVAC in the control and eradication of epizootic diseases in Africa, decided to elevate PANVAC to the level of an OAU Specialised Agency.

On the 8 July 2003, the Headquarters Agreement for PANVAC was signed during the AU summit between the Government of the Federal Democratic Republic of Ethiopia and the African Union, in Maputo (Mozambique) and by 12 March 2004, the Centre was officially launched as an African Union Regional Centre in its headquarters at Debre Zeit (Ethiopia) and the Department of Rural Economy and Agriculture of the AU Commission included PANVAC’s strategic plan into its 2004-2007 Strategic Plan.

AU-PANVAC mission, vision and mandate

The mission of AU-PANVAC is ‘to promote the availability of safe, effective and affordable veterinary vaccines, facilitate the development and the introduction of improved or new vaccines and strengthen Africa’s capacity building in veterinary vaccine and reagent development, production and quality assurance’ and the Vision is to ‘to build a recognised reference centre in the international arena for vaccine quality control, technology transfer, production of diagnostic and surveillance reagents and capacity building, driven by and for African professionals.’

In recognition of the role AU-PANVAC played in the eradication of rinderpest, the mandates of AU-PANVAC were expanded to include: providing international independent quality control of veterinary vaccines; facilitating the standardisation of veterinary vaccines production and harmonisation of their quality control techniques in Africa; promoting the transfer of appropriate vaccine production technologies to Africa; providing training and technical support services to veterinary vaccines production and quality control laboratories in Africa; and producing and distributing essential biological reagents for animal disease diagnosis and surveillance.

Vaccine quality control at AU-PANVAC

All vaccine producing laboratories are expected to implement strict quality assurance during production and to carry out both in-process and final quality control on the vaccines produced. However it is obligatory for all Vaccine Producing laboratories to send samples of each batch of ND vaccine produced to AU-PANVAC for independent quality certification. This obligation involves all vaccines produced or brought into Africa. The following are the laboratories currently producing ND vaccines in Africa.
Table 1. Laboratories producing ND vaccine in Africa

<table>
<thead>
<tr>
<th>Country</th>
<th>Laboratory</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameroun</td>
<td>Laboratoire National Veterinaire</td>
<td>Garoua</td>
</tr>
<tr>
<td>Nigeria</td>
<td>National Veterinary Research Institute</td>
<td>Vom</td>
</tr>
<tr>
<td>Niger</td>
<td>Laboratoire Central d’Elevage</td>
<td>Niamey</td>
</tr>
<tr>
<td>Mali</td>
<td>Laboratoire Central Veterinaire</td>
<td>Bamako</td>
</tr>
<tr>
<td>Chad</td>
<td>Laboratoire de Recherches Vétérinaires et Zootechiques FARCHA</td>
<td>Farcha N’Djamena</td>
</tr>
<tr>
<td>Senegal</td>
<td>Laboratoire National d’Elevage et de Recherches Veterinaires</td>
<td>Dakar Hann</td>
</tr>
<tr>
<td>Sudan</td>
<td>Central Veterinary Research Laboratory Soba</td>
<td>Khartoum</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>National Veterinary Institute</td>
<td>Debre Zeit</td>
</tr>
<tr>
<td>Kenya</td>
<td>Kenya Veterinary Vaccines Production Institute (KEVEVAPI)</td>
<td>Nairobi</td>
</tr>
<tr>
<td>Botswana</td>
<td>Botswana Vaccine Institute</td>
<td>Gaborone</td>
</tr>
<tr>
<td>Egypt</td>
<td>Vaccine and Serum Research Institute</td>
<td>Cairo</td>
</tr>
</tbody>
</table>

Presently the Veterinary Vaccine Producing Laboratory of Mozambique is producing the I-2 ND vaccine while Madagascar, Morocco, Tanzania and Zimbabwe are preparing to start production.

Submission of ND vaccine samples for quality control

Vaccine test request and initiation of testing by AU-PANVAC

Countries wishing to send vaccine samples to AU-PANVAC for quality control make a vaccine test request. AU-PANVAC then sends the following documents which are required for vaccine sample shipment:

1. Certificate of Origin
2. Sample Invoice
3. Sample Packing List
4. Certificate of Analysis
5. Submission Form

The client should complete and send these documents at least a week before dispatching the samples to AU-PANVAC to enable adequate preparation for the tests. On dispatch, the client is to send the Tracking Number for the shipment to enable adequate monitoring of the samples shipment from the point of dispatch to Addis Ababa airport.

Receipt and registration of vaccine at AU-PANVAC

On receipt at AU-PANVAC the vaccine sample is registered and an acknowledgement letter sent to the client stating the condition of the samples on receipt. If the samples arrive in good condition an acknowledgement letter is sent to the client giving the possible date of reporting of test results, usually one month from the date of receipt in the laboratory.

Vaccine quality control test at AU-PANVAC

AU-PANVAC conducts five major tests for the quality control of ND vaccines. These include: sterility test in bacteriological media; safety test in chickens; potency test by titration in embryonated eggs; identity test by PCR; and determination of residual moisture and vacuum for stability test. All laboratory analyses conducted at AU-PANVAC are based on the requirements of the OIE Manual of Diagnostic Tests.
**ND vaccines tested at AU-PANVAC from 2010 to 2012**

In 2010, a total of 122 batches of veterinary vaccines were tested by AU-PANVAC. Ten batches were ND vaccine and had a quality pass rate of 67%. The overall quality pass rate for all the vaccines certified by AU-PANVAC in the year was 80%.

In 2011, a total of 106 batches of veterinary vaccines were quality certified by AU-PANVAC. 11 were ND vaccines and had a quality pass rate of 91%. The overall quality pass rate for all veterinary vaccines was 88%.

In 2012, a total of 153 batches of veterinary vaccines were tested by AU-PANVAC. 25 batches were ND with a quality pass rate of 64%. The overall quality pass rate for all veterinary vaccines in that year was 80%.

**Requests for vaccine seeds and biologicals**

As part of the support to AU Member States (MS) and harmonisation of vaccine production on the African continent, AU-PANVAC supplies vaccine seeds and other biologicals to vaccine producing laboratories. In 2010, 59 requests were made from AU MS, 58 in 2011 and 72 in 2012.

**Conclusion**

In the implementation of its activities, AU-PANVAC will continue to provide services to AU MS in line with its mandates. AU-PANVAC is committed to ensuring the quality of ND vaccines produced and used on the African continent. As is the case with ND vaccines, AU-PANVAC will continue to collaborate with partners to strengthen its capacity in order to meet the increasing challenges of vaccine certification and animal disease control activities on the African continent.

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NEWCASTLE DISEASE CONTROL TOOLS

Comparative advantage of thermotolerant ND I-2 vaccine in the control of Newcastle disease in rural poultry in Ghana

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Background Information
Newcastle disease (ND) is endemic in many, if not all of African countries devastating both commercial and village poultry, with outbreaks reported year round. Over the years attempts to control the disease in rural poultry through the use of inactivated oil-adjuvant ND vaccines have yielded few positive results. This is because the vaccine is not affordable to rural poultry farmers, is packed in multidose vials (often 1,000 doses), requires expertise to administer it and is recommended for use only adult birds. The end results are low vaccination coverage and outbreaks with high mortality rates.

The ultimate approach to curbing this menace is the design and implementation of sustainable ND control measures. These measures must tackle the many hindrances to previous such approaches: low patronage of the thermotolerant NDI-2 vaccine; reluctance of field veterinary personnel to administer the vaccine; and governments not attaching economic importance to village chickens and therefore not supporting projects aimed at improving productivity.

This work therefore is aimed at demonstrating the comparative advantage of the thermotolerant NDI-2 vaccine over the inactivated oil-adjuvant vaccine in the control of ND in rural poultry thereby encouraging its nationwide usage.

Materials
- NDI-2 master seed from the Virology Department, University of Queensland, Australia
- Locally produced NDI-2 vaccine, quality tested
- Oil-strain Brescia > 10⁸ LD₅₀ Institute Zooprophylactic, distributed by 2Chemni DELA MILLETIERE, BP 7562, 37075 Tours CEDEX 2, FRANCE. Batch No. 2518
- Velogenic NDV field strain isolated in day 10 embryonated chicken eggs with an MDT <36 hours
- Wing tags
- Eye drop applicators
- Feather stripped to deliver 10µls of vaccine.

Procedure
- Three villages were selected as test sites and a fourth village as the control site where birds were not vaccinated.
- The birds in all the test sites and control site were wing tagged for ease of identification.
- The birds were bled for baseline information before vaccination in the test and control sites.
- In one village the birds were vaccinated with the NDI-2 via eye-drop; in the second village birds were vaccinated with NDI-2 by feather brushing of the eye; and in the third test village only adult birds were vaccinated with killed oil-adjuvant vaccine via intra muscular injection only once throughout the test period, as is the protocol.
• The birds were bled three weeks after the first vaccination and simultaneously vaccinated the second time only with the ND1-2 vaccine. This was repeated for a third time with only the ND1-2 vaccine being administered but birds in all the test and controls are bled.
• After the third bleeding and vaccination, some of the birds from all sites were bought back to the laboratory for challenge with a characterised virulent field isolate of ND virus
• The effectiveness of the vaccinations was monitored by serological analysis of sera samples collected and also field observation of the birds during periods of peak outbreaks of the disease in these villages compared with the control village.

Results
Field observation of vaccinated flocks
• There were no reported outbreaks of ND in the villages where the birds were vaccinated with the ND1-2 vaccine via the eye-drop route and also inactivated oil-adjuvant vaccine through intra muscular injection.
• In the site where I-2 was administered via feather brushing of the eye only a few cases of ND reported, but despite these farmers were very happy as the number of birds lost to the disease was much lower.
• In the non-vaccinated control site, the outbreak of ND was just as in the previous years when no intervention was initiated with most household losing almost all their flocks.

Serological results
Table 1 shows the results of haemagglutination inhibition tests performed on sera from control and vaccinated birds taken pre-vaccination and at three and 6 weeks post-vaccination.

Table 1. HI titre of control and vaccinated birds at 0, 3 and 6 weeks of vaccination

<table>
<thead>
<tr>
<th>Week of vaccination</th>
<th>Average HI titre (log2) of birds vaccinated via Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eye drop</td>
</tr>
<tr>
<td>0</td>
<td>1.8</td>
</tr>
<tr>
<td>3</td>
<td>3.2</td>
</tr>
<tr>
<td>6</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Buy-back challenge results
Table 2 shows the results of challenge of control and vaccinated birds using a characterised virulent field isolate of ND virus.

Table 2. Survival of vaccinated and control birds challenged with a virulent field isolate of ND virus

<table>
<thead>
<tr>
<th>Route of Administration</th>
<th>N. of birds challenged</th>
<th>N. of birds dead</th>
<th>N. of birds survived</th>
<th>Percentage survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDI-2 eye-drop</td>
<td>15</td>
<td>0</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>NDI-2 feather brushing</td>
<td>15</td>
<td>3</td>
<td>12</td>
<td>80</td>
</tr>
<tr>
<td>Inactivated oil vaccine</td>
<td>15</td>
<td>0</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>Control group</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Economic Advantage

1. Oil Inactivated Vaccine
   - Cost of a dose of inactivated vaccine: £C 120
   - Expertise charge to administer: £C 100
   - Total fee for administering one dose: £C 220
   - Returns on using oil vaccine: **10.5** from vaccination with the oil-adjuvant inactivated vaccine

2. Thermotolerant I-2 vaccine
   - Cost of one dose of thermotolerant ND1-2: £C 20
   - Expert fees for administration: £C 0
   - Differential cost for using ND1-2: £C 200

   Net return of **13.8** as a result of I-2 vaccination via the eye-drop route

Conclusion

- **NDI-2** is equally effective as inactivated oil-adjuvant vaccine in controlling ND in village poultry
- However the NDI-2 vaccine has the following advantages over the inactivated oil-adjuvant vaccine:
  - Cheap and affordable to farmers
  - Does not require strict cold chain facilities
  - Ease of application and therefore not requiring expertise to administer, hence
  - Farmers can apply the vaccines themselves thus encouraging administration of the vaccine at the farmers' convenience (could be done even at night when birds are roasting)
  - Produced locally and can be made readily available on demand
  - Cost benefit analysis also showed a much higher net return with I-2 vaccination via the eye-drop than with oil vaccine.
  - The vaccine can be administered to birds of all ages.

Recommendations

- Extensive public education to encourage adoption of NDI-2 as the vaccine of choice for the ultimate control of the disease.
- Local production of quality I-2 vaccine certified by AU-PANVAC, that is readily available and affordable to poultry farmers.
- The implementation of rigorous vaccination campaigns against ND using the NDI-2 vaccine three times a year at an interval of four months with the simultaneous control of Fowl pox and helminthiasis for improved rural production and productivity.
Newcastle disease surveillance activities
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Introduction
Newcastle disease (ND) is caused by virulent strains of avian paramyxovirus type 1 (APMV-1) of the genus *Avulavirus* belonging to the family *Paramyxoviridae*. There are ten serotypes of avian paramyxoviruses designated APMV-1 to APMV-10. ND virus (NDV) has been shown to be able to infect over 200 species of birds, but the severity of disease produced varies with both host and strain of virus.

Of all diseases affecting village chickens the single greatest impediment to the production of village chickens in Tanzania is ND. Circulating strains of NDV are capable of causing 100% mortality in unprotected flocks. Outbreaks of ND are unpredictable and discourage villagers from paying proper attention to the husbandry and welfare of their chickens. Control of ND in village chickens is an entry point to the development of this industry.

What is surveillance?
In the OIE Terrestrial Animal Health Code, in the specific appendix on ‘General guidelines for animal health surveillance’, ‘surveillance’ is defined as: ‘The systematic ongoing collection, collation, and analysis of data, and the timely dissemination of information to those who need to know so that action can be taken’. A well-functioning disease surveillance system provides information for planning, implementation, monitoring and evaluation of health intervention programs. The existence of a surveillance system able to provide reliable data is also necessary to document the health status of animal populations in an international trade framework and in the import risk assessment process.

Survveillance systems may have several objectives. In general, surveillance is aimed at demonstrating the absence of disease or infection, determining the occurrence or distribution of disease or infection, while also detecting as early as possible exotic or emerging diseases. The type of surveillance applied depends on the desired outputs needed to support decision-making. Animal health surveillance is an essential component necessary to detect diseases, to monitor disease trends, to control endemic and exotic diseases, to support claims for freedom from disease or infection, to provide data to support the risk analysis process, for both animal health and/or public health purposes, and to substantiate the rationale for sanitary measures. Surveillance data underpin the quality of disease status reports and should satisfy information requirements for accurate risk analysis both for international trade as well as for national decision-making.

The surveillance network system comprises the following elements: the herds, the owner or any other natural or legal person responsible for the holding, the approved veterinarian or the official veterinarian responsible for the holding, the official veterinary service of the Member State, the official veterinary diagnostic laboratories or any other laboratory approved by the competent authority, a computer database.

A well-functioning national surveillance system is the one that will provide:

- Prompt reporting
- Laboratory confirmed disease reports
- Reporting must be representative of the whole country
- Report must be followed by national action
- Standardised format for reporting, in order to manage risks and permit trade.
The surveillance system will have in place:

- a) a system for detecting and investigating outbreaks of disease or vNDV infection
- b) a procedure for rapid collection and transport of samples from suspect cases of ND to laboratory for ND diagnosis
- c) a system for recording, managing and analysing diagnostic and surveillance data.

**New definition for ND**

Until recently the OIE definition of ND was ‘a disease of birds caused by strains of avian paramyxovirus type 1, significantly more virulent than lentogenic strains’. This definition rested on the grouping of ND viruses into five pathotypes on the basis of clinical signs seen in infected chickens. However, the lack of objectivity in assigning viruses to the pathotype groups has caused difficulties in international trade, and led to the development of other tests to distinguish between strains.

The most widely used tests are the intracerebral pathogenicity index (ICPI) in day-old chicks and the intravenous pathogenicity index (IVPI) in 6-week-old chickens. More recently, sequencing studies of the fusion protein of paramyxoviruses have elucidated a molecular basis for pathogenicity. It appears that the amino acid sequence at the cleavage site of the virus fusion protein is a key determinant for infectivity and pathogenicity. Strains of the virus with multiple basic amino acids at the F0 cleavage site are virulent for their hosts, whereas strains with a single basic residue are avirulent. The most common amino acid sequences at the fusion protein cleavage site for strains of low virulence are 112G/E-K/R-Q/G-R-L117. Thus, at the 67th General Session of the International Committee of the OIE the definition of ND was changed as follows:

> ‘Newcastle disease is defined as an infection of birds caused by a virus of avian paramyxovirus serotype 1 (APMV-1) that meets one of the following criteria for virulence’

a) The virus has an intracerebral pathogenicity index (ICPI) in day-old chicks (Gallus gallus) of 0.7 or greater;

b) 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. Failure to demonstrate the characteristic pattern of amino acid residues as described above would require characterisation of the isolated virus by an ICPI test.’

(In this definition, amino acid residues are numbered from the N terminus of the amino acid sequence deduced from the nucleotide sequence of the F0 gene, 113-116 corresponds to residues -4 to -1 from the cleavage site.)

The new definition of ND has implications for international trade. Firstly, the classification of APMV-1 isolates into pathotype groups is no longer adequate. Secondly, an infection of any bird species with a virus fitting the new definition would affect the status of the country concerned, as disease in poultry is no longer the only focus.

**Surveillance for ND**

Definition of the principles and guidance on the surveillance for ND is provided by OIE in Articles 10.13.22 to 10.13.26 for members seeking to determine their ND status. This may be for the entire country, zone or compartment. Guidance for Members seeking free status following an outbreak and for
the maintenance of ND status is also provided. The Member should justify the choice of survey design and confidence level based on the objectives of surveillance and the epidemiological situation.

Surveillance for ND is complicated by the prevalence of APMV-1 infections in many bird species, both domestic and wild and the widespread utilisation of ND vaccines in domestic poultry. Consequently APMV-1 isolates should be characterised to differentiate vNDV (notifiable) from loNDV

The impact and epidemiology of ND differ widely and therefore also surveillance strategies employed will largely be based on the FAO classification of poultry production system into Sectors 1 - 4.

ND surveillance program
a) include early warning system throughout the poultry value chain for reporting suspicious cases. All suspected cases of ND should be investigated; sample submission to a laboratory for confirmatory diagnosis is very important
b) implement methods of surveillance:
   - Clinical or syndrome surveillance – focuses on detecting the clinical signs or lesions of ND
   - Virological surveillance - test for presence of NDV
   - Serological surveillance - to detect antibodies

Surveillance Strategies
- Surveillance programs aim to prove absence of vNDV infection circulation in a country, zone or compartment, using a sub-population representative of area
- Multiple surveillance methods should be used concurrently (active and passive)
- Surveillance should be composed of random and/or targeted approaches using clinical, virological and serological methods (epidemiologically appropriate design)

1. Targeted surveillance (e.g. based on the increased likelihood of infection in a population) may be an appropriate strategy. It may, for example, be appropriate to target clinical surveillance at particular species likely to exhibit clear clinical signs (e.g. unvaccinated chickens). Similarly, virological and serological testing could target species that may not show clinical signs of ND and are not routinely vaccinated (e.g. ducks).

   Surveillance may also target poultry populations at specific risk, for example direct or indirect contact with wild birds, multi-age flocks, local trade patterns including live poultry markets, the presence of more than one species on the holding and poor biosecurity measures in place. In situations where wild birds have been shown to play a role in the local epidemiology of ND, surveillance of wild birds may be of value in alerting Veterinary Services to the possible exposure of poultry and, in particular, of free-ranging poultry.

   The sensitivity and specificity of the diagnostic tests are key factors in the choice of survey design, which should anticipate the occurrence of false positive and false negative reactions. The results of active and passive surveillance are important in providing reliable evidence that no NDV infection is present in a country, zone or compartment.

2. Clinical surveillance aims to detect clinical signs suggestive of ND at the flock level and should not be underestimated as an early indication of infection. Monitoring of production parameters (e.g. a drop in feed or water consumption or egg production) is important for the early detection of NDV infection in some populations, as there may be no, or mild clinical signs, particularly if they are vaccinated. Any sampling unit within which suspicious animals are detected should be considered as infected until evidence to the contrary is produced. Identification of infected flocks is vital to the identification of sources of NDV.
Case definition of ND (probable?)
- Sudden death
- Greenish diarrhoea
- Discharge (clear or cloudy) from mouth, nose, ears or vent
- Locomotion abnormalities - unable to stand, flap wings
- Behavioural abnormalities - falling over, head tilt, paralysis, circling, head and neck twisting
- Mass mortalities.

A standardised case definition is needed to:
- ensure more uniform case finding
- ensure more uniform case reporting
- allow for reliable interpretation of data collected.

A presumptive diagnosis of clinical ND in suspect infected populations should always be confirmed by virological testing in a laboratory. This will enable the molecular, antigenic and other biological characteristics of the virus to be determined. It is desirable that NDV isolates are sent promptly to an OIE Reference Laboratory for archiving and further characterisation if required.

3. Virological surveillance should be conducted using OIE prescribed tests (egg inoculation, haemagglutinating activity, ICPI, molecular techniques) to:
   a) monitor at risk populations
   b) confirm suspect clinical cases
   c) follow up positive serological results in unvaccinated populations or sentinel birds
   d) test 'normal' daily mortalities (if warranted by an increased risk, e.g. infection in the face of vaccination or in establishments epidemiologically linked to an outbreak)

4. Serological surveillance is of limited value where vaccination is carried out. Serological surveillance cannot be used to discriminate between NDV and other APMV-1. Test procedures and interpretations of results are as described in the OIE Terrestrial Manual. Positive NDV antibody test results can have five possible causes:
   a) natural infection with APMV-1
   b) vaccination against ND
   c) exposure to vaccine virus
   d) maternal antibodies derived from a vaccinated or infected parent flock are usually found in the yolk and can persist in progeny for up to 4 weeks
   e) non-specific test reactions.

5. Sentinel poultry may be used as a surveillance tool to detect virus circulation. They may be used to monitor vaccinated populations or species which are less susceptible to the development of clinical disease for the circulation of virus. Sentinel poultry should be immunologically naïve and may be used in vaccinated flocks. Sentinel poultry should be in close contact with, but should be identified to be clearly differentiated from, the target population. Sentinel poultry should be observed regularly for evidence of clinical disease and any disease incidents investigated by prompt laboratory testing.
**ND Surveillance in Tanzania**

The surveillance system in Tanzania is based on passive and active surveillance activities, as in several African countries. The organisation and coordination functions reasonably well and the passive system is the prevalent one. The system works for:

a) detecting and investigating outbreaks of disease or vNDV infection
b) rapid collection and transport of samples from suspect cases of ND to laboratory for ND diagnosis
c) recording, managing and analysing diagnostic and surveillance data.

Disease control is the mandate of the Department of Veterinary Services.

The number of occurrences of ND in poultry recorded at the Central Veterinary Laboratory Dar es Salaam for the period 1999-2012 are summarised in Table 1 below.

![ND cases in poultry at CVL, Dar es Salaam 1999-2012](image)

**Figure 1.** ND cases in poultry at CVL, Dar es Salaam 1999-2012
Table 1. Number of cases of ND reported to the Epidemiology Unit MOLD and F 2008-2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Regions</th>
<th>Districts</th>
<th>Foci</th>
<th>Cases</th>
<th>Deaths</th>
<th>At Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>10</td>
<td>15</td>
<td>31</td>
<td>2,325</td>
<td>1,848</td>
<td>78,604</td>
</tr>
<tr>
<td>2009</td>
<td>6</td>
<td>8</td>
<td>14</td>
<td>7,444</td>
<td>5,124</td>
<td>61,416</td>
</tr>
<tr>
<td>2010</td>
<td>10</td>
<td>13</td>
<td>27</td>
<td>7,114</td>
<td>3,942</td>
<td>157,298</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>8</td>
<td>15</td>
<td>1,989</td>
<td>1,590</td>
<td>39,569</td>
</tr>
<tr>
<td>2012</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>2,047</td>
<td>1,945</td>
<td>48,166</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>50</td>
<td>95</td>
<td>20,919</td>
<td>14,449</td>
<td>385,053</td>
</tr>
</tbody>
</table>

The temporal and spatial distribution of ND outbreaks 2010

Figure 2. ND distribution 2010

There are many factors impeding running a proper epidemic surveillance. These include financial, logistical and technical constraints. Specifically constraints may be identified as:

- Vastness of the coverage area
- Poor coordination among players
  - livestock and wildlife
  - low reporting rate and poor disease reporting
  - low flow of information - LGAs to Veterinary Investigation Centres (VIC) and wildlife
- Inadequate working support services
  - laboratory consumables - reagents, chemicals
  - reliable transport facility
  - erratic flow of recurrent funds

39
Multiple disease challenges:
- emerging and re-emerging
- livestock/wildlife interface issue

The evidence collected and the analyses used to reach any conclusion should be reliable enough for the results to be acceptable to both the managers of the monitoring and surveillance systems and the assessors.

References
Introduction

Geographical Location of Cameroon

Cameroon is a country located in central Africa, between the Atlantic Ocean and the Lake Chad basin. It covers a surface area of about 475,442 km² with over 16,290,000 inhabitants. The country is divided into ten regions: Adamawa, North, Far North, North West, West Littoral, Centre, East, South and South west regions. The economy of Cameroon is principally based on agricultural activities. The 2005 Gross Domestic Product (GDP) was estimated to be 8,770.7 billion CFA (13.37 billion Euros) (BEAC 2005). The country contributes 44% of GDP in the CEMAC zone. The livestock sector represents about 20% of this GDP with 30% of the population dependent on livestock activities (PACE-Cameroon 2007).

The poultry industry

The poultry sector constitutes a very important part of the livestock sector of the Cameroonian economy. The poultry population in Cameroon was estimated at about 45 million and about 60% was found to be reared using the traditional or extensive system, distributed throughout the national territory (FAO 2006. Table 1 shows the poultry population in each production system. Poultry in the commercial farming system (modern or semi-modern) are concentrated in the peri-urban areas of Douala, Yaoundé, Bafoussam and to a lesser extend in Kumba (FAO 2006). The traditional system of farming, which constitutes 60% of the national poultry population, is not homogenously distributed throughout the national territory and is characterised by absence of shelter for the birds, low productivity and a relatively low interaction between farmers and their birds. The commercial systems (modern and semi-modern) are characterised by external dependence on supply of day old chicks and a relative external dependence on inputs (feeds, production materials, vaccines, antibiotics etc.) (Baschirou 2008).

Table 1. Poultry population distribution per production system

<table>
<thead>
<tr>
<th>Management System</th>
<th>Population</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Million</td>
<td></td>
</tr>
<tr>
<td>Traditional system</td>
<td>24.8</td>
<td>55</td>
</tr>
<tr>
<td>Semi-intensive commercial system</td>
<td>20.3</td>
<td>45</td>
</tr>
<tr>
<td>Small commercial holdings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broilers</td>
<td>10.0</td>
<td>49</td>
</tr>
<tr>
<td>Layers</td>
<td>4.3</td>
<td>21</td>
</tr>
<tr>
<td>Medium and large commercial holdings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broilers</td>
<td>4.3</td>
<td>21</td>
</tr>
<tr>
<td>Layers</td>
<td>1.8</td>
<td>9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>45</td>
<td></td>
</tr>
</tbody>
</table>

- The poultry sector constitutes about 1% of GDP, 15 billion CFA (US$30 million) of net annual profit and provides about 14% animal protein needs.
- Accumulated Deficit (2008-2015) of 410,000 tonnes if nothing is done to salvage the sector and if the consumption (4.1 kg/ P/ year) does not increase.
- Poultry farms are under threat from epizootic diseases such as Newcastle disease (ND), infectious bursal disease, infectious bronchitis and avian influenza.
There is an annual loss of 70% in village chickens, with about 50% caused solely by ND. This represents a loss of 30,000 tonnes meat equivalent to 3 billion FCFA (US$6 million)/year.

**Epidemiology of ND in Cameroon**

ND is a highly infectious and highly contagious viral disease of birds with worldwide occurrence. Anseriformes (e.g. waterfowl) and Psittaciformes (e.g. parrots) are sub-clinical carriers. These sub-clinical carriers intermittently shed strains of highly virulent ND virus that are devastating to other species of poultry; consequently they are very important in the epidemiology of the disease. Ostrich of all ages are susceptible to infection with virulent ND virus.

ND remains a serious threat to both intensive and extensive poultry production. The nature and effects of ND are very devastating consequently; it is an OIE listed disease. Its morbidity and mortality could be as high as 100%. The virus is ubiquitous with a wide host range that includes reptiles and humans.

In Cameroon, the disease is enzootic and is a threat to both intensive and extensive production systems. Most domesticated species of birds are affected with chickens, especially village chickens greatly affected. The traditional poultry farming system constitutes 55 to 60% of the national poultry industry and ND is the most important disease (resulting in over 50% loss). In villages, the peasant farmers watch helplessly as all their birds die due to this epizootic.

ND occurs during mostly in the month of July in the Eastern region, July to September in the West region and October to December and sometimes March in the North region (Abegde et.al. 1992).

**Table 2. Some statistics of the disease (2005–2010)**

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New outbreaks</strong></td>
<td>7</td>
<td>37</td>
<td>29</td>
<td>10</td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td><strong>Number of cases</strong></td>
<td>467</td>
<td>8,538</td>
<td>4,645</td>
<td>6,077</td>
<td>5,421</td>
<td>1,698</td>
</tr>
<tr>
<td><strong>Number of deaths</strong></td>
<td>430</td>
<td>6,467</td>
<td>3,989</td>
<td>5,750</td>
<td>4,813</td>
<td>1,472</td>
</tr>
<tr>
<td><strong>Total at risk</strong></td>
<td>3,658</td>
<td>44,798</td>
<td>21,356</td>
<td>20,743</td>
<td>12,349</td>
<td>4,347</td>
</tr>
<tr>
<td><strong>Morbidity rate</strong></td>
<td>12.8%</td>
<td>19.1%</td>
<td>21.8%</td>
<td>29.3%</td>
<td>43.9%</td>
<td>39.1%</td>
</tr>
<tr>
<td><strong>Mortality rate</strong></td>
<td>11.8%</td>
<td>14.4%</td>
<td>18.7%</td>
<td>27.7%</td>
<td>39.0%</td>
<td>33.9%</td>
</tr>
</tbody>
</table>

Source: [WWW.DSVCameroun.org](http://WWW.DSVCameroun.org)

**Some factors favoring propagation of the disease**

Illegal trade, porous borders, and free range management system (village chicken) favour propagation of disease.

**Transmission**

Transmission is mostly direct by excretions and secretions (buccal, nasal and ocular secretions) and indirectly by infected or contaminated vehicles, personnel, birds, and wind.
Diagnosis and Reporting

Diagnosis

Clinical diagnosis:
This is performed mostly by field veterinarians and is based on clinical signs and lesions.

Figure 1. Clinical signs of ND
**Laboratory diagnosis**
The National Veterinary Laboratory-Garoua and her branch laboratories are responsible for diagnosis of ND. The techniques used are:

A. Virus isolation in specific pathogen free embryonated eggs
   (Disadvantage: takes a long time; SPF eggs required)

B. Serology - haemagglutination inhibition test (HI)
   (Disadvantage: more of retrospective test and needs two sample collections within an interval of two weeks to confirm infection.)

C. Polymerase chain reaction (PCR) conventional and real time PCR.

**Table 3.** Distribution of reported cases/laboratory confirmed cases of ND 2005 to 2012

<table>
<thead>
<tr>
<th>Infectious disease</th>
<th>Number suspected outbreaks/number confirmed outbreaks by lab</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
</tr>
<tr>
<td>ND</td>
<td>87/53</td>
</tr>
</tbody>
</table>

**Reporting**

**Reporting by field veterinarians**
When a case of ND is suspected based on clinical signs and lesions, the Chief Veterinary Centre closest to the farmer reports it to the Subdivisional Delegate who in turn reports the case to the Divisional Delegate. The Divisional Delegate then reports the case to the Regional Delegate who in turn reports to the Chief Veterinary Officer. The Chief Veterinary Officer then declares the case to the OIE.

![Field Vet. Reporting Diagram](image)

**Figure 2.** Schematic illustration of disease system reporting by field veterinarians
**Reporting by the laboratory**
After performing the tests, the technicians send the results to the Chief of Service for virology who validates the results and prepares a report. He signs the report and sends it to the Director of Diagnostic department who also signs the report. The report is then submitted to the Director General of LANAVET who signs the report. The report is then sent to the Chief Veterinary Officer of Cameroon who declares the case to the OIE.

![Laboratory Reporting Diagram]

**Figure 3.** Schematic illustration of laboratory reporting system of diseases

**Control strategies**
Biosecurity and vaccination (using vaccines produced by LANAVET and some imported) are the main measures used to control ND and these measures are mostly implemented by large commercial farms. However, as you move from sector 1 (Industrial) toward sector 3 (small commercial) there is a tendency for farmers to neglect vaccination and even biosecurity measures.

In Cameroon, the traditional poultry farming system constitutes 55 to 60% of the national poultry industry and ND is most important disease, causing over 50% loss. In villages, the peasant farmers watch helplessly as all their birds die due to this epizootic. These birds are seldom vaccinated.

**National Control Programs**

**Panafrican Program for the Control of Epizootics (PACE)**
This program was funded by European Union and was implemented to control epizootics (including rinderpest, PPR and ND). Though the European Union funding ended, the epidemiological surveillance network that was set up at that time is still functional.

**Support Project for Development of Village Poultry Farming (French acronym ‘PADAV’)**
This program was set up by the Cameroon government and helps in:
- Mass vaccination campaigns against ND in villages in the 10 regions of country since 2009; the vaccinators are MINEPIA agents
- Internal and external parasite control.
Constraints and opportunities

Constraints
- The laws governing control of notifiable diseases exist but are not well implemented by those concerned.
- Vaccines are not affordable to peasant farmers.
- Illegal trade, porous border and free range management (village chickens and other birds) favour propagation of disease.
- Low number of samples submitted to the laboratory for testing due to cost and lack of laboratory reagents.

Opportunities
- The existence of laws governing notifiable diseases
- The production of vaccines against ND (Multivax trivalent vaccine: Newcastle, Fowl typhoid, Fowl cholera) by LANAVET-Garoua
- The production of thermostolerant vaccine I2 by LANAVET-Garoua
- The extension of diagnostic laboratories: LANAVET is creating new branches: The Yaoundé branch is already operational. The Bafoussam and Ngoundéré will soon be operational.
- The existence of the National Support Program for the development and production of village chickens.

Conclusion
- ND is enzootic in Cameroon.
- More effort is needed to control the disease especially in village chickens.
- A regional approach is imperative to control the disease as borders are porous.

Acknowledgments
My gratitude to the KYEEMA Foundation for funding the project and my appreciation goes to AU-PANVAC for inviting me. I would like to thank the Directorate of Veterinary Service of Cameroon for providing me with some of the information used in this paper. I am highly indebted to Director General of Lanavet for giving me the opportunity to attend this meeting. I am also very grateful to Dr Yaya Aboubakar for selecting me to attend this conference.

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Country report Egypt
Dr. Seham El Zeedy
Veterinary Serum and Vaccine Research Institute
Egypt

Vaccines prepared at VSVRI

<table>
<thead>
<tr>
<th></th>
<th>DOSES PER YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Live Vaccines</strong></td>
<td></td>
</tr>
<tr>
<td>Hitchner B1</td>
<td>12,000,000</td>
</tr>
<tr>
<td>La Sota</td>
<td>15,000,000</td>
</tr>
<tr>
<td>Komarov</td>
<td>80,000,000</td>
</tr>
<tr>
<td>Hitchner + IB</td>
<td>30,000,000</td>
</tr>
<tr>
<td>La Sota + IB</td>
<td>30,000,000</td>
</tr>
<tr>
<td><strong>Inactivated Vaccines</strong></td>
<td></td>
</tr>
<tr>
<td>Oil inactivated ND vaccine</td>
<td>20,000,000</td>
</tr>
<tr>
<td>Combined bivalent ND +IBDV</td>
<td>5,000,000</td>
</tr>
<tr>
<td>Combined trivalent ND + IB + EDS</td>
<td>10,000,000</td>
</tr>
</tbody>
</table>

Evaluation of Vaccines
All batches were evaluated by the Central Laboratory for Evaluation of Veterinary Biologics (CLEVB), which is responsible for all imported and locally prepared vaccine.

Studies conducted by General Organization of Vet. Services and Animal Health Institute of Poultry Producers’ Union.
200 farms (small, medium and large) from January to July 2012
  170 broiler farms
  25 layer farms
  1 turkey farm
  3 duck farms

Samples collected
From 163 farms
  248 tracheal swabs
  306 organs (trachea, lung, kidney, bursa, cloaca)
2,351 blood samples from 24 farms
26 feed samples

Diagnosis and isolation of causative agent
Pathogenicity studies
Techniques
• conventional polymerase chain reaction (PCR)
• real time PCR
• haemagglutination inhibition
• isolation of agent in embryonated SPF eggs
• genetic analysis

Results
Newcastle disease virus was isolated
Percentage of ND infection was 8.5% (because of vaccination)
Newcastle disease control in Ethiopia
Dr Martha Yami
National Veterinary Institute
Ethiopia

Disease reporting
Despite the huge population of the backyard chickens in Ethiopia (42 million), there is no a serious poultry disease reporting system in the country.

Vaccination is the main means of controlling poultry disease in the country.

Vaccine production
Currently, NVI has a capacity to produce 25 million doses of Newcastle disease (ND) vaccine per year. As can be seen from the table below, the vaccine utilisation is far from this figure.

All poultry vaccines produced at NVI are freeze-dried. ND vaccine is produced from HB1, La Sota and I-2 strains.

<table>
<thead>
<tr>
<th></th>
<th>2010 (doses)</th>
<th>2011 (doses)</th>
<th>2012 (doses)</th>
<th>2013 (doses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>2,764,600</td>
<td>2,897,500</td>
<td>8,324,400</td>
<td>3,418,350</td>
</tr>
<tr>
<td>Thermotolerant I₂</td>
<td>456,300</td>
<td>166,000</td>
<td>2,662,700</td>
<td>617,800</td>
</tr>
</tbody>
</table>

The conventional vaccines are destined mainly for private commercial farms and government poultry multiplication centres and in few instances, for small holder private farms holding 500-1000 chickens.

Due to the low interest in backyard chickens usage of the thermotolerant vaccine in the country is very limited. The thermotolerant vaccine is used in backyard chickens in areas where NGOs are involved or where the extension service is more active. Apart from local use NVI is exporting I₂ vaccine to other African countries. Newcastle vaccine was supplied to different African countries under the VACNADA project.
Epidemiology of Newcastle disease

Newcastle disease (ND) is caused by the Newcastle disease virus (NDV) which belongs to the family Paramyxoviridae, Group V viruses according to the Baltimore classification. These are single stranded negative sense viruses (Mononegavirales). The genus is Avulavirus and species avian paramyxovirus (APMV). Currently, avian paramyxoviruses (APMV) consist of ten distinct known serotypes (APMV1–10) and the numbers will increase due to isolation and identification of new serotypes. NDV is a well-characterised species within the same genus and is named APMV-1.

Since its isolation and characterisation in 1926 ND has been reported to be endemic in many countries including Ghana. One of the most characteristic properties of the different strains of the ND virus has been their variation in pathogenicity in chickens. Five pathotypes of ND have been reported based clinical signs in infected birds and are as follows:

1. Viscerotropic velogenic: highly pathogenic strains which cause haemorrhagic lesions in visceral organs
2. Neurotropic velogenic: strains that present with high mortality and signs of nervous system impairment
3. Mesogenic: a form that presents with respiratory signs and occasional nervous signs but with low mortality
4. Lentogenic: a form that presents with mild or subclinical respiratory infections, and
5. Asymptomatic enteric: that usually presents with subclinical enteric infections.

In Ghana ND has been one of the most devastating diseases of poultry (commercial intensive system and free range scavenging) over the years. In the commercial intensive system of poultry production in Ghana, where prophylactic vaccination against the disease is practised rigorously, there are records of outbreaks of the disease even among vaccinated flocks with mortality rates as high as 80%, sometimes 100% on a flock basis. The disease is responsible for the devastation of the free range scavenging rural poultry, the main source of protein and income for a majority of rural Ghanaian communities, with total annual losses of poultry due to ND of up to 80% of the total flock.

The future of poultry in Ghana therefore depends greatly on the effective and sustainable control of ND.

Diagnosis and reporting

Like any infectious disease, the diagnosis of ND starts with a consideration of epidemiology, clinical signs, necropsy and confirmation by specific laboratory diagnosis. However, with the outbreak of highly pathogenic avian influenza due to the H5N1 subtype (HPAI H5N1) with similar clinical and pathological presentations as ND, definitive diagnosis of ND involves the differentiation from HPAI.
In Ghana, the Accra Veterinary Laboratory is designated as the centre for the diagnosis of HPAI and ND. The flow of work in investigating clinical cases and confirming a diagnosis of ND is as follows:

- **Gross pathology**
- Rapid antigen detection test with the purpose of establishing a timely result for the immediate implementation of control measures. Some rapid antigen detection assays can differentiate HPAI from ND even though they are of low sensitivity.
- Virus isolation in 9–11 day old embryonated chicken eggs. This also affords the possibility of establishing the pathogenicity (MDT) of the strain of the virus involved in the outbreak
  - identification of isolates by haemagglutination inhibition (HI) Test
  - conventional RT-PCR and
  - real time RT-PCR assay and isothermal Loop Amplification (LAMP) assay (recently established).

The number of clinical cases of ND confirmed by the laboratory over the past five years is shown in Table 1.

**Table 1. Number of cases of ND confirmed at the AVL 2008-2012**

<table>
<thead>
<tr>
<th>Number of ND cases confirmed at the AVL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>49</td>
</tr>
</tbody>
</table>

These cases are from commercial flocks because commercial farmers routinely report outbreaks to the laboratory. The real picture will definitely be different because cases of ND among rural poultry are rarely reported.

A confirmed ND outbreak is immediately reported to the client (the farmer) and also the relevant authorities who will implement control measures to prevent spread. These include the Chief Veterinary Officer and the Central Epidemiology Unit who report to OIE, then the Regional and District Veterinary officers of the outbreak focus.
ND control strategies in Ghana

With the confirmation of a ND outbreak, the Veterinary Services Directorate (VSD) immediately implements measures to contain the infection. This is usually quarantine (movement control) and proper disposal of carcasses and infected litter. There is no depopulation since the VSD has no funding for the compensation of affected farms.

Prophylactic vaccination against ND is rigorously practised especially in the commercial poultry sector in Ghana. This involves the use of two live vaccines in poultry at 2 and 6 weeks of age and an inactivated oil-adjuvant vaccine at point of lay. If properly done, this should confer protective immunity for the whole production life of laying flocks, however, because of the reports of outbreaks of the disease among vaccinated flocks, poultry farmers have adopted the periodic vaccination (boostering) of laying flocks with live vaccines, which seems to be compounding the problem of ND outbreaks. The Accra Veterinary Laboratory conducts post-vaccination monitoring of farms to ensure effective vaccination against ND.

Several seminars have been organised by the VSD to educate farmers in the intensive commercial poultry sector on the need to improve biosecurity on farms. Following this the VSD drafted modalities for the certification of commercial poultry farms based on their level of biosecurity implementation.

In the rural communities in Ghana, the administration of NDI-2 vaccine for the prevention of outbreaks of ND is gradually gaining ground. The vaccine is administered at least three times to a bird before the peak period of ND outbreaks in Ghana (October – February). Communities which have accepted the vaccine have seen a significant improvement in rural poultry production.

Constraints and opportunities

The control of ND in Ghana faces a huge number of constraints. These include the following:

1. The disease is widespread in the rural poultry sector. Even though the NDI-2 vaccine is produced in Ghana its administration in the field is not nationwide. This is because of lack of financial support for field veterinary services to encourage its usage.
2. Lack of potent and efficacious ND vaccines in the commercial sector. The implementation of the Government’s procurement laws allows importers with the lowest bid to bring vaccines into the country with little regard for quality.
3. No uniform vaccination regime.
4. Poor biosecurity of commercial farms, which allows an outbreak in an area to spread quickly.
5. No legislation backing the VSD to enforce disease control measures.
6. The unified extension system has greatly undermined the practice of veterinary medicine in the country.
7. Understaffed veterinary services with poor logistical support for effective work.

The opportunities Ghana has to ensure sustainable ND control include the following:

- A well-structured veterinary service with presence in all regions and districts of the country
- Well educated and skilled personnel
- Active veterinary laboratory services in all regions of the country to support timely and accurate disease diagnosis
• A well-equipped and active NDI-2 vaccine production laboratory in Accra capable of producing the required quantity of good quality vaccine. The laboratory now produces both wet and freeze-dried vaccine for prolonged shelf life.
• Government support (through WAAPP Project) for vaccine production.

Conclusion
Sustainable control of ND in Ghana depends greatly on the simultaneous control of the disease in both the extensive and intensive systems of poultry production, through the use of certified quality vaccines, improved biosecurity, rapid and accurate diagnosis of any incursions and the timely implementation of effective control measures.

Figure 2. Healthy village chicken flock in Ghana
**Madagascar**

‘Kristiana Mpanao Vaksiny – KMV’ network, biological evaluation of Newcastle disease and fowl cholera vaccination campaigns and their socio-economic impact in Analanjirofo region

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1Veterinary Vaccines Institute, Madagascar

2Veterinary and Livestock Research Department, Madagascar

**Summary**

Since April of 2003, ‘Kristiana mpanao Vaksiny or KMV’ networks have been set up within the FJKM Afvoany Antsinanana Vaovao or SPAAV Synod in the Analanjirofo region, an autonomous province of Toamasina. 343 KMV were trained in simple vaccination techniques against Newcastle disease, fowl cholera and fowlpox. The KMV are divided and work in three ‘Faritra Miara – Mivavaka’ or FMM to ensure fowl vaccination: FMM1 in Vavatenina with 141 KMV; FMM2 of East Fenerive with 106 KMV and FMM3 of Soanierana Ivongo and St. Marie with 96 KMV. Since the establishment of KMV, over 41,500 flocks of chicken have been vaccinated and are protected mainly against Newcastle disease and fowl cholera. The vaccines are PESTAVIA® and AVICHOL® respectively, produced by the Veterinary Vaccines Institute, Madagascar.

A study on the operation of the KMV networks and a biological evaluation of different vaccination campaigns were undertaken. Results of faecal examination obtained by the flotation technique using 65% of potassium iodide solution indicate that deworming of birds for internal parasites has never been practised. *Capillaria* species were present in 32% of the samples and *Ascaridia* sp. in 22%. Furthermore, polyparasitism was pervasive.

The serological study using the haemagglutination inhibition technique (HI) which reveals the presence of antibodies against the Newcastle disease virus showed seroconversion rates exceeding 90% for the areas covered by the KMV.

The socio-economic impact of routine fowl vaccination is important to the farmers, particularly during the socio-political crisis from 2009 to 2011. Indeed, the gain per family per year is estimated to be more than 350,000 Ariary (MGA) within the area covered by the KMV.

The following points should be noted:

- The KMV have successfully integrated the training provided on vaccination and the basic concepts on predominant poultry diseases. The KMV networks are feasible and operate well.
- Polyparasitism and the problem of cold chain during vaccine transportation seem to affect the strength of the immune response in vaccinated animals present in Analanjirofo region.
- The use of PESTAVIA® vaccine reduces the risk of Newcastle disease mortality in vaccinated chickens by 35.10 times.
- The improvement of village poultry through routine vaccination against Newcastle disease and fowl cholera helps solve the malnutrition problem in rural areas.

**Conclusion**

The Rio Declaration on Environment and Development - ACTION 21 stipulates in its resolution concerning the promotion of a sustainable agriculture and rural development that: ‘...
animal breeds have in addition to their sociocultural value, the unique characteristics with regard to the adaptation, the resistance to diseases and the specific uses should be well preserved. These local breeds are threatened as a result of the introduction of exotic breeds and changes introduced in the methods of livestock production. (7)

IMVAVET is convinced that the improvement in village chickens, composed mainly of local breeds (Akoho amambra Gasy) is an effective way to fight food insecurity due to lack of protein and improve the purchasing power of rural population. Control of avian diseases especially Newcastle disease, avian cholera and fowlpox among local animal resources is a priority. IMAVET believes is a question of giving responsibility and directly involving our farmers in the prevention and control of animal diseases, particularly among local breed chickens.

The example of the ‘Kristiana Mpanao Vaksiny ny akoho amambra’ network in collaboration with the FJKM - SPAAV Synod of Analanjirofo region is an example of an approach that is technically reliable, sustainable and has the potential to reduce poverty in rural areas. Routine vaccination against Newcastle disease in village poultry reduced the prevalence of Newcastle disease by 35.10 times. The KMV were recruited from the FJKM Christian community. They were trained and tasked to carry out the vaccination activities. The results of the clinical and serological results show that this work was well executed.

Taking into account the purchasing power of the rural population and of the duration of the production cycle of chickens ‘Gasy’, approximately 4 to 5 months, village poultry provide a valuable source of income for rural families. In particular, it helps to overcome the deficit in protein among the most vulnerable of the rural population, thus aiding in the fight against malnutrition.

Our next efforts will deal with improving the network. In the medium term we will progressively introduce simple techniques appropriate to the rural areas to improve the management of village poultry.
An overview of Newcastle disease control in Malawi

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Introduction

Approximately 80% of rural families in Malawi keep chickens and chickens make a substantial contribution to household food security of all livestock species (Department of Animal Health and Livestock Development - DAHLD 1999). Chickens are used for consumption, sale, and gifts, rituals and barter. Free-range scavenging rural chickens constitute about 71% of the chicken population in Malawi.

Intensive poultry production in Malawi has expanded in recent years, but most poultry is still husbanded in smallholder units. This smallholder production supplies an important source of protein and income especially in rural areas.

The main constraint to the expansion and increased productivity of the local chicken population is the frequent devastation of flocks reportedly up to 90% of the flocks in some areas due to Newcastle disease (ND). Control of ND by routine vaccination on a cost recovery basis is a priority in village scavenging chickens. Control of disease in commercial flocks, particularly infectious bursal disease (Gumboro disease) and salmonella is the responsibility of the private sector although DAHLD has a monitoring and regulatory role. The productivity of the poultry industry could indeed be enhanced if ND was controlled.

There are a number of conventional vaccines available for control of ND in the commercial poultry sector in Malawi. These have effectively controlled the disease and reduced the incidence in commercial poultry farms. However some conventional ND vaccines, especially La Sota which have been put to use in the control of ND in free-range rural scavenging chickens, have yielded little success. Unconfined chickens, transport problems, high ambient temperatures and lack of refrigeration pose special problems of ND control in scavenging village chickens. One possible solution to this problem is the use of vaccine strains of ND virus (NDV) that have been selected for thermotolerance.

The epidemiology of ND

Nature of the disease

ND is a contagious disease affecting many domestic and wild avian species in the country. Its effects are most notable in domestic poultry due to their high susceptibility and the potential for severe impacts of an epidemic nature on the poultry industries. In Malawi the disease is mostly endemic.

The surveillance system

The surveillance system for ND in Malawi is largely passive, i.e. it depends on reports from farmers and field staff. The primary source of information is the farmer at the poultry unit. Reports come through the designated communication pathway (Figure 1). However disease detection and reporting are erratic. However, in terms of disease focus the system can be described as general and the disease is notifiable, with confirmations done on samples submitted to the Central Veterinary Laboratory, which is the national veterinary laboratory.
Figure 1. The communication flow under the surveillance system for ND in Malawi

This surveillance system targets the entire chicken population in Malawi. The species of interest is the bird or chicken whilst the epidemiological unit is the village. In commercial settings the epidemiological unit is the flock in a batch since these are raised in intensive systems. The potential coverage of this system is generally 100%. The primary data is based on clinical signs which farmers observe in their chickens.

The spatial distribution of ND reports in Malawi

In terms of spatial distribution, the disease has been reported in all 28 districts of Malawi. However there is a variation in terms of the reporting frequency (Figure 2)
**Figure 2.** Monthly cumulative ND reports in selected districts from 2000 to 2010

**The temporal distribution of ND in Malawi**

In Malawi the disease is endemic. However the temporal distribution of the disease varies throughout the year (Figure 3).

**Figure 3.** Temporal distribution of ND in Malawi (2000-2010)
The diagnosis and reporting of ND

Suspected ND outbreaks are mostly detected based on the clinical picture in the field. The field staff and poultry farmers have been trained in clinical signs of ND using a standard case definition. Outbreaks are mostly reported based on clinical signs and confirmation is done at the Central Veterinary Laboratory. The test used is the haemagglutination assay and is done in the virology section. Screening tests are also conducted in commercial poultry units to certify them free of the clinical disease and/or determine the immune status of the flocks following routine vaccinations.

Between March 2011 and May 2012, the Central Veterinary Laboratory received a total of 483 samples (7 organs, 476 sera) for ND testing. Three out seven tissue samples tested positive for ND using HA/H1 test whilst 351 out 476 sera tested positive (had protective titres) using the ELISA screening test.

Control strategies

The goal of ND control in Malawi as stipulated under the animal disease control policy is early containment and reduction of occurrences of the disease in poultry with eventual progression to eradication. The main objective is to control the disease so as to increase poultry production and household income.

The main strategy is the use of integrated ND control employing timely vaccinations with appropriate, effective vaccines and biosecurity measures (Livestock Policy, DAHLD 2006).

Currently, Malawi is promoting the use of thermotolerant I-2 ND vaccine which is being produced at the Central Veterinary Laboratory. This followed successful laboratory and field trials which were conducted in 2004-05 with the support of the AusAID funded Southern African Newcastle Disease Control Project (SANDCP). The laboratory and field trials showed that the locally produced I-2 ND vaccine induced high antibody levels in vaccinated chickens and conferred protective immunity against natural challenges of ND in scavenging chickens. A follow-up project with support of the KYEEMA Foundation improved the capacity for production, quality control and the outreach program for vaccination. The incorporation of the private sector and NGOs has strengthened the ND control approach in up-scaling vaccine access. The use of community vaccinators and local leadership is crucial to acceptance by the community.

Therefore, vaccination with I-2 vaccine has shown undoubted potential to control ND and improve production of scavenging village chickens. Vaccine production has therefore won full Government intervention and support. However there is still a need to expand capacity for production through increase of space for production, training of more personnel, provision of more critical equipment, improvement of the quality assurance system and vaccine delivery to the field.

Since its introduction, the I-2 ND vaccine production level has generally increased with slight variations (Figure 4). The vaccine has gained very high popularity among the rural poultry farmers.
Some of the notable challenges and opportunities with respect to ND control include:

- Underreporting of cases by poultry farmers, i.e. most local poultry farmers hesitate to report suspected cases for fear that the control strategy may involve destruction of the sick and in-contact birds.
- Farmers may not be able to present clinical signs properly. Farmers that are close to CVL tend to report more cases than those that are far from CVL.
- Districts that have more and better qualified staff tend to submit more samples than those with fewer and less qualified staff.
- Reports of deaths of chicks after vaccination are not uncommon.
- Emergence of diseases other than ND, e.g. fowlpox after successful ND control.
- Low vaccine production due to low capacity affects vaccination coverage.
- Low earnings by community vaccinators from vaccination campaign are likely to affect the sustainability of the ND control program.
- Vendors vaccinating chickens in project villages frustrate community vaccinators.
- Lack of participation by some trained community vaccinators.
- Current political will to promote livestock development particularly for small-scale rural farmers and willingness and of the private sector and NGOs to actively participate in the ND control initiatives.
- Local production and registration of I-2 ND vaccine with well established distribution system having potential for up scaling.

**Conclusion**

ND still remains the main constraint in the expansion of village based poultry in Malawi. Control of ND by routine vaccination on a cost recovery basis is a priority in village scavenging chickens. There is vast opportunity to fully control the disease if the current gains on the instituted integrated control measures particularly on the timely and appropriate use of I-2 and other approved thermotolerant ND vaccine are sustained.
Country report Mali
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Central Veterinary Laboratory
Mali

Introduction
Mali is located in sub-Saharan Africa with 70% of its population living in rural areas and 30% in urban areas.

The livestock sector occupies an important place in the economic, social and cultural arena of the country. Its contribution to the gross domestic product (GDP) is 13% and it occupies third place after gold and cotton in the export sector. Farming is practised by 80% of the population and particularly by the poor. This sector is rich and diverse and the poultry sector is favoured by the majority.

Mali has approximately 36.5 million poultry distributed among the rural, semi-industrial and industrial sectors in the sub-urban areas. This booming activity contributes to the achievement of food security, nutrition and poverty reduction. Poultry farming provides a valuable source of income and addresses protein deficit among the population.

The losses attributable to diseases are the main factor discouraging poultry farmers and hampering the development of the poultry industry in our country. Despite the absence of reliable statistics on the overall economic impact of avian disease, four infectious diseases are identified as the main causes of mortality. Among them Newcastle disease (ND) is the most significant. That is why the development of the modern and traditional poultry industries is among the priorities of the Department in charge of livestock in Mali.

Disease epidemiology
Definition
ND is a transboundary poultry disease. It spreads rapidly within and between countries, which necessitates implementation of transboundary disease control defined by the Emergency Prevention System or EMPRES program: early detection, early warning, fast and rapid response. The control of this disease makes sense only if there is a coordinated response over large geographical areas with a community approach to make it efficient and sustainable. Consequently, it will be essential to provide awareness on dangers and potential risks of the disease on the family economy and the national economy as a whole to livestock management staff, the stakeholders in the sector (poultry farmers, feed producers etc.) and authorities.

ND is a paramyxovirus. Most domestic and wild birds are susceptible to the virus. The gallinaceous species are most often affected by the disease. Pigeons can be infected by the variant virus. ND is sub-clinical in ducks and geese but they can be carriers of viral strains potentially pathogenic for other species.

Epidemiology
ND is one of the main constraints to the development of the village poultry industry in Mali. Mortalities are very high due to lack of appropriate planning. The disease alone is responsible for more than 70% of the cases of disease in rural poultry (The Special Program for Food Security (SPFS) Mali 1998; Central Veterinary Laboratory 2000). The cyclical nature of the disease and the loss of almost all flocks during outbreaks are indicators that can be easily verified.
A survey conducted from 1996 to 2000 aimed to contribute to the study of ND epidemiology in rural areas. Four sites were chosen in the south and north Sudan, Sahelian and inner Niger Delta agro-climatic zones. An observer was based in each site to monitor the clinico-epidemiological situation in livestock. When there were disease outbreaks, samples were sent to the Central Veterinary Laboratory of Bamako (CVL) for analysis. The study established that the average rate of prevalence was 32.9% with a variation between 12.1% in the south Sudan zone, and 38.8% in the Sahelian zone. The cold dry season, with 63% of cases, was the peak outbreak period compared to the rainy season during which a rate of 15% was recorded. The species affected were chickens, guinea fowl and turkeys. The rates of morbidity, mortality and fatality varied between 8%, between 5.7 and 82% respectively, and between 10 and 100%. Three peak periods were established: January, May and November. The highest number of cases of ND were recorded in 1998.

The 2000-2001 progress report of the SPFS Mali, GCSP/MLI/022/NET, FAO indicated that vaccination coverage against this disease was around 17% in 2000 for the whole country and 38.7% at SPFS Kangaba site in 1999. These rates are largely inadequate for a country with endemic ND such as Mali.

As part of ND epidemiological surveillance, surveys financed by the GRIPAVI project of French Cooperation were carried out in 2009, 2010 and 2011. In November to December 2009, samples were collected from 1,024 birds (32 per village) comprising 938 chickens, 43 guinea fowl, 21 ducks, 14 pigeons, 6 turkeys and 2 geese. The results of the competitive ELISA test using the IDvet are stratified according to the vaccination status as vaccination is expected to produce seropositive animals. Generally, the investigation showed a seroconversion rate of 89.8% among vaccinated animals. This rate varied depending on the species and could probably be attributed to the low number of samples collected from species other than chickens.

The percentage of non-vaccinated animals that are seropositive is high (75.1%) indicating a strong movement of ND virus in the villages under survey, as indicated in Table 1 below.

**Table 1. Detection of antibodies against ND (November-December 2009)**

<table>
<thead>
<tr>
<th></th>
<th>Vaccination against ND</th>
<th>Negative</th>
<th>Positive</th>
<th>Total</th>
<th>Seropositive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ducks</td>
<td>No</td>
<td>10</td>
<td>5</td>
<td>15</td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>25%</td>
</tr>
<tr>
<td>Turkeys</td>
<td>No</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>Geese</td>
<td>No</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0%</td>
</tr>
<tr>
<td>Pigeons</td>
<td>No</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>16%</td>
</tr>
<tr>
<td>Guinea Fowl</td>
<td>No</td>
<td>16</td>
<td>5</td>
<td>21</td>
<td>24%</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>10</td>
<td>12</td>
<td>22</td>
<td>54%</td>
</tr>
<tr>
<td>Chickens</td>
<td>No</td>
<td>74</td>
<td>308</td>
<td>382</td>
<td>81%</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>42</td>
<td>513</td>
<td>555</td>
<td>92%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>No</td>
<td>108</td>
<td>325</td>
<td>433</td>
<td>75.1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Yes</td>
<td>60</td>
<td>528</td>
<td>588</td>
<td>89.8%</td>
</tr>
</tbody>
</table>

In September 2010, a similar investigation was conducted in 887 birds (841 chickens, 12 guinea fowls, 17 ducks and 17 pigeons) and showed 96.1% seroconversion rate among the vaccinated
animals. The percentage of non-vaccinated animals that were seropositive was high (76.2%) showing high ND virus circulation as seen in Table 2 below.

**Table 2. Detection of antibodies against ND (September 2010)**

<table>
<thead>
<tr>
<th>Vaccination against ND</th>
<th>Negative</th>
<th>Positive</th>
<th>Total</th>
<th>Seropositive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ducks</td>
<td>No</td>
<td>1</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Pigeons</td>
<td>No</td>
<td>15</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Guinea Fowl</td>
<td>No</td>
<td>7</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Chickens</td>
<td>No</td>
<td>60</td>
<td>256</td>
<td>316</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>21</td>
<td>503</td>
<td>524</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>No</td>
<td>83</td>
<td>266</td>
<td>349</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Yes</td>
<td>21</td>
<td>516</td>
<td>537</td>
</tr>
</tbody>
</table>

In February 2011, a similar investigation was conducted in 1,005 birds, (951 chickens, 35 guinea fowls, 17 ducks, 2 pigeons) and showed 87.4% seroconversion rate among vaccinated animals. This rate varied according to the species. The seropositive rate among the non-vaccinated animals was 67.2% indicating high ND virus circulation in the village under study as shown in Table 3 below.

**Table 3. Detection of antibodies against ND (February- March 2011)**

<table>
<thead>
<tr>
<th>Vaccination against ND</th>
<th>Negative</th>
<th>Positive</th>
<th>Total</th>
<th>Seropositive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ducks</td>
<td>No</td>
<td>2</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Pigeons</td>
<td>No</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Guinea Fowl</td>
<td>No</td>
<td>0</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>10</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>Chickens</td>
<td>No</td>
<td>140</td>
<td>276</td>
<td>416</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>59</td>
<td>475</td>
<td>534</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>No</td>
<td>144</td>
<td>295</td>
<td>439</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Yes</td>
<td>71</td>
<td>493</td>
<td>564</td>
</tr>
</tbody>
</table>

**Diagnosis and disease reporting**

**Disease diagnosis**
The tests used by the Central Veterinary Laboratory (CVL) for the diagnosis of ND are:
- agar gel immunodiffusion (serum)
- haemagglutination inhibition (serum): according to the protocol of the OIE reference laboratory/IZSVE/FAO
- haemagglutination (virus detection): according to the protocol of the OIE reference laboratory/IZSVE/FAO
- virus isolation by culture in eggs
• cELISA (serum) with IDvet competitive ELISA kit for ND virus (NDVC-10P) specific detection of anti-NDV antibodies and ELISA NDVC-10P (virus) for detection of the virus

• PCR: diagnosis on the fusion gene F (organs, cloacal swabs and pharyngeal swabs) according to the protocol of the OIE reference laboratory (IZSVe of Padova)

• rapid tests ('penside': Kit One step Newcastle Disease Virus Antigen Test; Antigen Rapid NDV Ag Test Kit; 10 tests per kit. Bionote Company, Inc, Korea: result: 2 minutes; chromatography system.

Table 4 shows the results of ND outbreaks diagnosis from 2006 to 2013 at CVL. Poultry farms registered the highest rate of ND positive (confirmed) cases in 2009 and 2011, respectively.

Table 4. Results of the ND outbreak diagnosis from 2006 to 2013 at CVL

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of cases</th>
<th>Number of confirmed cases</th>
<th>Percentage of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>13</td>
<td>2</td>
<td>15.4</td>
</tr>
<tr>
<td>2007</td>
<td>10</td>
<td>3</td>
<td>30.0</td>
</tr>
<tr>
<td>2008</td>
<td>10</td>
<td>2</td>
<td>20.0</td>
</tr>
<tr>
<td>2009</td>
<td>28</td>
<td>17</td>
<td>60.7</td>
</tr>
<tr>
<td>2010</td>
<td>18</td>
<td>11</td>
<td>61.1</td>
</tr>
<tr>
<td>2011</td>
<td>18</td>
<td>14</td>
<td>77.8</td>
</tr>
<tr>
<td>2012</td>
<td>15</td>
<td>6</td>
<td>40.0</td>
</tr>
<tr>
<td>2013</td>
<td>7</td>
<td>4</td>
<td>57.1</td>
</tr>
</tbody>
</table>

Disease reporting
The number of samples received for the confirmation shows an under-reporting of ND cases.

Strategy for ND control
Institutional context and partnership
Since 2006, a Technical Coordination Committee for the fight against avian influenza (CTC) meets every week, and has put in place surveillance measures in line with the action plan to fight against avian influenza and ND. Periodic monitoring of the disease is carried out by the state and private veterinary services.

Epidemiological surveillance of the disease has been conducted from 2009 to 2011 under the GRIPAVI project financed by French Cooperation. The results are given above in the section 'Epidemiology'. This project has helped to strengthen diagnostic capacity through training of laboratory managerial staff and provision of diagnostic material.

Control of the disease
ND control is carried out through vaccination, in the framework of which the following are used in the poultry farms:

• imported avian vaccines

• avian vaccines manufactured by the CVL (Newvac and Avivac-i2).

  Newvac is an inactivated vaccine against ND.

  Avivac-i2 (10⁶ EID +10% trehalose) is a live thermotolerant lyophilised vaccine manufactured with i2 ND vaccine strain.
**Constraints and opportunities**

The main constraints remain to be:

- the weakness in disease reporting resulting in low number of samples received at the CVL despite the free service
- the high cost of chemical reagents, equipment and laboratory equipment
- laboratory equipment maintenance.

The opportunities would be to take advantage of and participate in the consolidation of the RESOLAB which must be able to integrate into sub-regional institutions like UEMOA and ECOWAS.
Newcastle disease control in Mozambique

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Introduction

Mozambique key facts

The Republic of Mozambique is located in southeastern Africa, covers an area of 790,367 km² and 2,515 km coastal lowlands, and has a tropical to sub-tropical climate. The estimated population is 23,700,700 inhabitants, among them 12,274,400 women, 52% (www.ine.gov.mz, accessed June 2013). The capital and largest city is Maputo and the only official language of Mozambique is Portuguese, which is spoken mostly as a second language by about half of the population. The country became independent from Portugal on 25 June 1975. The official currency is the Metical as of June 2013, US$1 was roughly equivalent to 29 Meticals. The average annual GDP per capita (actual) is US$535.

Village poultry production

The agricultural census (2010) indicated that the majority of the people in rural areas have the tradition of poultry keeping, especially village chickens. The village poultry population is estimated to be 23,922,192.

Village chicken production is a suitable tool for food security and nutrition, poverty reduction and promising livelihood strategy in rural areas. In Mozambique, village poultry production is an important component of rural development. The majority of chicken are kept in small-scale extensive traditional systems in rural areas and they supply most of the poultry meat and eggs consumed in rural areas. Poultry constitutes almost the only source of animal protein especially for children, elderly people, pregnant women and vulnerable people and is an important source of income for the majority of rural families during periods of food shortages or where the agriculture potential is low (Mavale 2001). Village poultry are also useful for special traditional ceremonies and events in rural areas.

There are a considerable number of constraints to village poultry production, namely predation, poor feeding, poor management and diseases. The most frequently reported poultry diseases are: Newcastle disease (ND), fowlpox and parasitosis. ND is considered endemic in Mozambique, occurring every year and affecting mainly village chickens. ND constitutes the major constraint to village chicken production.

Epidemiology of ND

A number of factors may favour the maintenance of the ND virus (NDV) in village poultry. Chickens, ducks, pigeons, turkeys, guinea fowl, wild birds, man, wild and domestic mammals such as cats, dogs and rodents play a significant role in the persistence of ND. Rural poultry flocks usually consist of several numbers of species, including ducks, which are resistant to ND. The ducks can become a source of infection, contributing to the maintenance and transmission of the virus to susceptible chickens. Village chickens that recover from the disease may shed the virus after recovery and become a source of NDV to susceptible birds.
**Diagnosis of ND**
The Central Veterinary Laboratory (CVL) in Maputo, has the capacity (qualified personnel, infrastructure and equipment) to carry out diagnostic tests for ND but at field level the diagnosis of ND depends entirely on clinical signs. The field staff and community vaccinators are trained to recognise the main signs of the disease.

At the CVL ND diagnosis is done by virus isolation in embryonated eggs, HA/ HI, ELISA and RT-PCR tests.

**Reporting of ND**
The provincial livestock services report disease outbreaks through disease notification reports to the Epidemiology Department. The reports are complemented by monthly reports from the CVL. The number of reported outbreaks in village chickens does not reflect the true extent of the disease. The DNSV states in its annual report that animal diseases are under-reported, despite efforts to improve the situation. These efforts include training the field staff to use field disease outbreak report forms and analyse the laboratory reports. A section was added to the Community Vaccinators’ record book where vaccinators can record and monitor ND outbreaks. This is to encourage villagers and extension workers at all levels to report ND outbreaks.

**Strategy for ND control**
ND is considered a disease of strategic importance in the whole country and vaccination against ND is an effective method of preventing the disease. To implement ND control in village chickens the Veterinary Authority has established a Control Strategy for the rural areas to reduce the incidence of the disease through immunisation using thermotolerant live avirulent or inactivated vaccines.

Vaccination of village chickens using thermotolerant vaccine was introduced by ACIAR-INIVE project, which ran from 1996 to 2001. Vaccination campaigns against ND are organised and carried out by the animal health workers and community vaccinators.

The vaccinators are under the supervision of rural extension network (public or NGOs) and district livestock officers. The involvement of women is crucial to the success of the ND control program since it is well known that chicken raising is mainly the responsibility of women. A female vaccinator is able to work more easily with female farmers. An increase in the number of women trained as vaccinators increases the confidence of women farmers in adhering to the vaccination program and increases their capacity to take decisions.

**Local vaccine production**
Table 1 shows the quantities of thermotolerant I-2 vaccine produced by the Directorate of Animal Sciences (DCA) in Mozambique. The vaccine is still not registered in Mozambique and has been used in five provinces out of 11 as pilot vaccinations. However, the preparations for the registration of the vaccine with the Department of Drug Registration in the Ministry of Health are ongoing.
Table 1. I-2 Vaccine production at DCA (2010-2012)

<table>
<thead>
<tr>
<th></th>
<th>March</th>
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<th>November</th>
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<td>2013</td>
<td></td>
<td></td>
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</table>

Constraints

There are a number of constraints to sustainable ND control in village chickens including:
- The cold chain for vaccine storage at district level is inadequate in some districts.
- The percentage of vaccine utilisation per dropper is still below 60%.
- In some villages the farmers are reluctant to pay for the vaccination services.
- Lack of poultry housing for village chickens makes the implementation of vaccination campaigns difficult.
- Poor involvement of local government and community leaders in awareness and mobilisation programs for ND control.
- Lack of timely reporting of ND outbreaks in village poultry due to limited contact between villagers and livestock staff who are mainly based at district headquarters.

Opportunities

A number of opportunities are also present and this encourages the government to continue the struggle to control ND. These opportunities are:
- A new freeze-drier has been installed at DCA and staff training has been conducted. The freeze drier will allow the production of the vaccine in advance and consequently avoid delays in vaccine distribution for the vaccination campaigns. Stocks of I-2 vaccine can be maintained at central and provincial levels and the planning of vaccination campaigns can be improved.
- The dossier for registration of I-2 vaccine prepared in 2005 was updated and submitted to the competent authority within the Ministry of Health. It includes information on both freeze dried and liquid vaccine. The registration of the I-2 vaccine will ensure its use throughout the country.
- A project to accelerate progress towards MDG 1c in Mozambique funded by the EU has recently been approved. The project includes a livestock component that aims to strengthen the capacity of DCA in I-2 vaccine production.
- Studies carried out to monitor pre- and post-vaccination ND antibody levels in village chickens vaccinated against ND using I-2 vaccine demonstrated that the vaccine stimulated good levels of protection in vaccinated chickens.
- The baseline surveys and PRAs carried out in different sites revealed that ND vaccination campaigns are well accepted by farmers and reduce the mortality of chickens due to ND.

Conclusions

The MDG report states that poverty levels in Mozambique have been reduced from 69.5% in 1997 to 54.7% in 2009, but there is still much to do if MDG 1c (reduce by half the proportion of people suffering from hunger by 2015) is to be met. This is because 35% of the population is still food insecure and 43% of children under five are chronically malnourished (stunted). It is believed that the target could be met if coordinated interventions by all participants including
Government of Mozambique, donors and civil society, are implemented to increase agricultural production, access to markets and improve nutrition. The coordination of ND activities lead by AU-PANVAC and KYEEMA Foundation is seen as a great opportunity to improve production and incomes of smallholder farmers through adoption of sustainable ND control practices and participatory methodologies.

Acknowledgements
The authors would like to acknowledge the support given to village poultry production and development by the Australian Centre for International Agricultural Research (ACIAR), the Australian Agency for International Development (AusAID), the Food and Agriculture Organization of the United Nations (FAO). Our gratitude is extended to our colleagues at the Directorate of Animal Sciences of the Agricultural Research Institute of Mozambique, the veterinarians, poultry specialists, extensionists at the Ministry of Agriculture and non-government organisations, Community vaccinators and farmers in many parts of the country who have given freely of their time and expertise over the years.

References


Country Report - Niger
Aminata Djibo
Laboratoire Central de l’Élevage
Niamey-Niger

Administrative and legal status
Ministry of Livestock, Directorate General, Administrative Public Institution

Name of Administrative Manager
Dr Djibo Aminata

Geographical coverage
Central Livestock Laboratory of Niamey (Headquarters): covers the regions of Niamey and Dosso

Regional Laboratory of Tahoua: covers the regions of Tahoua and Agadez

Regional laboratory of Tillabery: covers the regions of Tera, Tillabery

Regional laboratory of Zinder: covers the regions of Zinder, Diffa and Maradi

Institutional and Historical framework
The Central Livestock Laboratory was established in 1965 and provides structural support to the Ministry of Livestock in relation to animal and public health. Since then it has undergone a number of structural changes:

1965-1975 Unit of the Institute of Tropical Countries Livestock Veterinary Medicine.
1980-1982 The vaccine production section was under the Livestock Directorate whereas veterinary and livestock research was under Niger National Institute of Agricultural Research.
1986 Establishment of Tahoua and Zinder laboratory unit.
1987-1991 The Livestock Laboratory was modified into Industrial and Commercial Public Establishment.
1991-1998 With an order, the Central Livestock Laboratory was transformed to an Administrative Public Establishment.
1998 Following Law No. 98-019 of 15 June 1998, the Administrative Public Establishment was dissolved, and the Veterinary Laboratory Directorate was established by Decree No. 98-179PRN/MAG/EL of 2 July which includes re-organisation of MAG/EL.
2009 November: under order No. 2009-20 of 3 November 2010, and its implementation Decree No. 2010-258/PCSRD/MAG/EL of July 2011, the Central Livestock Laboratory was restructured as an Administrative Public Establishment.

Mission of the Central Livestock Laboratory
- Animal diseases diagnostic laboratory
- Participation in the design, implementation and monitoring of applied veterinary research programs
- Participation in the design and implementation of investigation and epidemiological surveillance programs
- Implementation of biological, chemical and biochemical analysis of products, veterinary inputs and livestock
- Implementation of microbiological analysis of food-stuffs of animal origin
- The production, control and marketing of biological products mainly veterinary vaccines and sera
- Training of laboratory and veterinary officers in animal diagnostic techniques
- Publication of results.

Structure of the Central Livestock Laboratory (Administrative Public Establishment)
The Executive Board of the Central Livestock Laboratory encompasses:

At the central level
- Director General
- Quality Assurance Service
- Director General Secretariat
- Administrative and Finance Directorate
- Diagnostic, Investigation and Training Directorate
- Vaccine Production Directorate
- Biological Products Control and Analysis Directorate.

At regional level
Management of regional laboratories
Three units: Regions of Tahoua, Tillabéry, and Zinder

Human Resources

<table>
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<tr>
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<th>Laboratory of Tahoua</th>
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<td>5</td>
<td>3</td>
<td>2</td>
<td>60</td>
</tr>
</tbody>
</table>

Financial sources
Internal resources are mainly gained from vaccines sales and secondly from the contract services delivered to projects dealing with diagnosis and epidemiological investigations (rare cases). However for the time being diagnosis is provided free.

External resources
At the national level, in addition to its internal resources, the Central Livestock Laboratory receives a government subsidy to ensure its management.

Activities
Diagnostic and Epidemiological investigations
The Central Livestock Laboratory has the capacity to undertake tens of thousands of analyses per year. In relation to the priority diseases monitoring of pan-African projects for the Control of Epizootics and Avian Influenza, the Central Livestock Laboratory has played an important role in diagnosis, investigation and serosurveillance as well as training of veterinary officers.
Serology
- ELISA test, complement fixation test, agglutination test, agar gel immuno-diffusion test, precipitation test, tuberculin test, immunofluorescence, serum neutralisation, haemagglutination inhibition.

Bacteriology
- Microscopic tests:
  - Fresh state
  - Stained smears: Gram; Ziehl Neilsen; May-Grunwald Giemsa; Giemsa (simple); KOxTER stain (modified); Macchiavello stain; Stamp stain.
- Plating: isolation and identification of bacteria and mycoplasmas

Virology
- Culture, isolation and identification of Morbillivirus (rinderpest virus; peste des petits ruminants virus) on vero cells or primary calf kidney cells
- Rabies diagnosis using immunofluorescence test

Parasitology
- Coproscopic (faecal) examination; autopsy; research and identification of pests.

Molecular biology
- Conventional and real time PCR

Vaccine production
The Central Livestock Laboratory has the capacity to produce 15 to 20 million doses of vaccines per year (with proper equipment and provision of inputs). Currently seven vaccines are produced:

- PERIVAC: vaccine against contagious bovine pleuropneumonia
- OVIPESTIVAC: vaccine against peste des petits ruminants
- CARBOVAC: vaccine against Anthrax
- SYMPTOVAC: vaccine against blackleg
- PASTOBOVAC: vaccine against pasteurellosis of large ruminants
- PASTOVAC: vaccine against pasteurellosis of small ruminants
- DERMOVAC: vaccine against sheep pox and cattle lumpy skin disease

Vaccine quality control
Titration, sterility test, safety, purity and potency, applied to viral and bacterial vaccines.

Constraints
Currently, the Central Livestock Laboratory is encountering several problems that hinder its performance:
- Out-dated equipment
- Lack of qualified staff to maintain equipment
- Poor condition (running down) of premises, power installation and plumbing
- Inadequate number of management personnel qualified to undertake research

However, a solution to the first problem is found through the Niger Agricultural Productivity program initiated by ECOWAS (World Bank financing) to replace obsolete heavy equipment.
Prospects
Search other opportunities to strengthen our resources, such as:
- Request payment for the diagnostic service
- Formalise the plan for setting up a laboratory for analysis of foods of animal origin
- Develop other vaccines: the vaccine against Newcastle disease, bivalent vaccine against sheep pox, cattle lumpy skin disease and peste des petits ruminants
- Improve the quality of our services (implement Quality and Procedures Manual).
Country report Nigeria
Tony Joannis, Mohammed Ahmed and Ponman Solomon
National Veterinary Research Institute
Nigeria

Introduction
Location
West Africa; shares border with Benin, Niger, Chad and Cameroon

Human Population
140 million
Sheep
28 million
Cattle
15.16 million
Pigs
6.6 million
Goats
45.06 million
(NB: Based on projections from 1990 census)
Poultry
170 million
Commercial 25%
Semi-commercial 15%
Rural/ backyard 60%

Agricultural GDP
9-10%

Throughout Nigeria, communities and rural households have been keeping poultry for generations, and these chickens are predominantly the indigenous breeds. They are kept for different purposes ranging from their use for sacrifices at traditional festivals, traditional healing, as source of meat for households and a way of generating income. Nigeria is the largest country in West Africa and shares borders with Benin, Niger, Chad and Cameroon. Its human population is estimated at about 140 million. Based on projections from 1990 census, Nigeria has a livestock population of 28 million sheep, 15.16 million cattle, 6.6 million pigs and 45.06 million goats. The Nigerian poultry population is estimated at 150 million, with rural and backyard poultry mainly of indigenous stock constituting 84% (Adene and Oguntade 2006). Agriculture contributes about 9-10% to the total Gross Domestic Products (GDP) of the country.

In Nigeria, family poultry represents approximately 94% of total poultry keeping and account for about 4% of the total estimated value of the livestock resources in the country. This sector has helped in improving the micro economy of households, as the income from the sales is used for food, children’s school fees and other unexpected expenses such as medicines. Unlike cattle, sheep and goats which require large areas for grazing and a long time span to gain returns from the investment, family poultry requires little land and has a promise of quick returns on investment. The size of family poultry flocks in Nigeria range from 5-100 (FAO 2004).

Poultry production remains a viable bail-out for the average Nigerian family, both in terms of guaranteed supply of animal protein and economic returns. The sector has the capacity to employ the large population of unemployed youth through the provision of jobs in the various sub-sectors. However, the development of this important sector is constrained by a lot of factors which ranges from poor government policies and disease burden of various kinds, the most devastating being Newcastle disease (ND).

ND is a highly contagious viral disease affecting wild and domestic avian species and is one of the most serious diseases in the poultry industry (Alexander 2000, 2001). The virus is transmitted...
by ingestion or inhalation and produces a disease with varied clinical severity and manifestations. Depending on the pathotype involved and the susceptibility of the flock, the virus causes mortality ranging from 0-100% (Nanthakumar et al. 2000).

**Epidemiology**

ND is endemic in Nigeria with frequent epidemic outbreaks in susceptible commercial, backyard and village poultry (Nwanta et al. 1953). Intensive poultry farmers in Nigeria vaccinate poultry routinely, but the largely extensive rural poultry remains susceptible and unvaccinated.

The first documented outbreak of the disease in chickens occurred in Ibadan in 1952 (Hills et al. 1953). Since then, the disease has been the most important disease of chickens in Nigeria, apart from highly pathogenic avian influenza (HPAI H5N1) in the recent past.

In a participatory community appraisal on factors affecting poultry production in rural households across the country, ND was ranked first as the major constraint to rural poultry production (personal interview with village dwellers 2010).

**ND reporting**

Most outbreaks of ND especially in rural chickens are not reported. Generally, documented details of losses associated with ND in Nigeria are limited. However, available data indicates that ND is the leading cause of death and losses in both commercial and rural poultry. Between 1977 and 1982, ND was responsible for 38 of 135 reported poultry disease outbreaks in commercial and backyard poultry farms all over the country (FDL and PCS 2008; FLD 1987). In 1988, an average of 200-250 outbreaks of the disease was recorded.

A study on the diseases affecting local chicken in northern Nigeria reported that ND alone accounted for 36.1% of the disease burden. In the year 2000, ND alone accounted for 76% of losses in the poultry industry compared to other poultry diseases like Gumboro, fowl cholera, fowl typhoid. From 1996–2005, out of a total of 3,164 reported cases of poultry diseases in Kaduna, North West Nigeria, 1,050 were diagnosed as ND (Nwanta et al. 2008).

Between 2009 and 2012 a total of 23,848 samples from nationwide active surveillance were analysed. 388 ND isolates were recovered from different species of birds and 98% of the isolates were of the velogenic type.

**Diagnosis**

Field diagnosis is based on flock history, clinical manifestations and post-mortem findings consistent with the disease. Confirmatory laboratory diagnosis is based on virus isolation and or molecular detection and differentiation.

**NVRI laboratory diagnostic capacity**

The National Veterinary Research Institute Vom has capacity for ND virus isolation in embryonated hen eggs and identification by ND specific antisera. Virus pathotyping is by Mean Death Time and intracerebral pathogenicity index. Molecular detection by both conventional and real time RT-PCR We are also optimising our real time protocols for the rapid pathotyping of NDV from field samples.

Our sequencing equipment is awaiting installation. At the moment, we maintain a repository of over 700 isolates. However, we lack the capacity for advanced genomic analysis for the purpose
of monitoring the rapid evolutionary dynamics of NDV as it relates to its epidemiology and control.

Reporting
Field suspicions are reported to the epidemiology unit of the Federal Ministry of Agriculture (FMA) while the laboratory also sends its reports to the FMA. The Epidemiology unit reports to the OIE. However reporting is weak and inconsistent.

Control strategies
Commercial flocks
The major ND control measure in Nigeria is vaccination. However, this is generally applied only to commercial poultry only. The use of commercial vaccine in rural poultry is limited by cost, the large number of doses per vial and lack of thermotolerance. As a result, most rural poultry remain unvaccinated and highly susceptible to ND with the associated economic losses.

The vaccination program for commercial flocks in Nigeria involves the use of 3 types of live ND vaccines: ND I/ O (a B1 lentogenic strain-derived vaccine) administered by eye-drop at day-old for priming, followed by ND-La Sota (lentogenic strain) administered orally in drinking water at day 21. At six weeks of age, ND-Komarov (mesogenic strain) is administered intramuscularly and repeated at sixteen weeks (Okeke and LaMorde 1988). All the vaccines are produced by the National Veterinary Research Institute, Vom, Nigeria.

In the last two decades, there has been an influx of foreign ND vaccines; as a result, a wide range of live and inactivated oil based vaccine from other parts of the world are in use in the country. Despite vaccination, ND outbreaks in Nigeria have been frequent and widespread in vaccinated commercial and unvaccinated rural flocks. Reasons such as poor quality vaccines, poor handling and improper administration have been advanced for outbreaks in vaccinated flocks.

Rural poultry
To address the problem of rural poultry vaccinations, the NVRI is into demand driven production of the ND I-2 vaccines for use in the rural areas. Field trials using ND I-2 vaccine produced in Vom have been conducted in village chickens across the country with very good results.

Besides the production and distribution of the vaccine, the institute partners with states and local authorities in addition to non-government organisations to carry out vaccination of rural poultry in limited locations using the ND I-2 thermostolerant vaccine. However most of the rural poultry remain unvaccinated and highly susceptible to ND with the associated economic losses.

In 2012, NVRI, in collaboration with states and local governments, trained extension workers and farmers in the handling and administration of the I-2 vaccine to rural chickens

Constraints
1. Recent studies on the NDVs in west and central Africa revealed the circulation of very distinct virulent lineages of the virus. More worrisome is the high rate of evolution of the virus especially in Nigeria. There is need for further studies to determine the efficacy of current ND vaccines.
2. Lack of convenient and effective delivery systems for ND I-2 vaccine.
3. Low level of extension service coverage in the rural areas.
4. Nigeria shares international borders with many countries and most of these borders are very porous with a lot of transborder sales and movement of live poultry which make it difficult for disease control at the national level.
5. Failure of governments to appreciate the socio-economic importance of rural poultry.
6. Lack of facilities and expertise for advanced genomic analysis to better the understanding of the evolution and epidemiology of ND.
7. A weakened surveillance system after the avian influenza outbreaks.

Opportunities
NVRI has:
1. The capacity for sustainable large scale commercial production and distribution of ND I-2 vaccine for national and regional usage.
2. A large minimal disease poultry flock for production of embryonated hen eggs for vaccine production and virus isolation.
3. A large number of well-trained skilled personnel for vaccine production, quality control and disease diagnosis.

Unemployed youth and women can be recruited as extension workers to train farmers on administration of ND I-2 vaccine.

Conclusion
1. ND is endemic in Nigeria.
2. The national surveillance system needs to be strengthened. Also, efforts should be made to organise and sustain surveillance for ND at both national and sub-regional levels. This will provide comprehensive data on the epidemiology and molecular characteristics of NDV isolates from Nigeria and by extension the sub-region.
3. The production capacity for quality ND I-2 vaccine production exists within the country. However, awareness on the use of ND I-2 should be expanded, especially in rural areas so that it will be used in a sustainable manner.

References

Newcastle disease control in village poultry farming in Senegal: some promising results

El Hadji Traoré, Ndye Fatou Tall Ndiaye, Fatou Tall Lo and Ibou Sy
Senegal Institute of Agricultural Research – National Veterinary Laboratory Research and Vaccines
Production Unit, P.O. Box 2057, Dakar

Introduction

Family poultry is found in most village households. It is a source of easily mobilised income, and if well managed it can be an efficient and effective means to alleviate poverty and a great source of protein for the population, particularly for those in rural areas (Talaky 2000). In fact, rural poultry involves nearly all socio-economic strata of the country, especially women and children (Guèye 1998; Traoré et al. 2006; Traoré 2008; Ndayésinga 2010). It represents the cash that covers all daily basic necessities, medicines and school materials etc. (Talaky 2000).

However, as used traditionally the return is low compared to what should be gained and this is due to several problems related to inefficient farming. In fact, most of the chickens are kept in bad conditions, poorly fed and devastated by diseases like Newcastle disease (ND) (Alders and Spradbrow 2000) and parasitic diseases. According to the research of Traoré and Faye, ND was found to be the major cause of chicken mortality followed by the parasitic diseases.

To allow poultry farmers to gain the maximum profit, there is a need to improve their farming practice, particularly by mastering ND and parasitic disease control through training and demonstration. Thus, several activities have been undertaken in recent years by the Research and Agricultural Council to facilitate access to thermotolerant I-2 vaccine and to popularise its use in rural areas. Furthermore, the commitment of the Senegal Government to promote traditional poultry farming has been realised through the National Agricultural and Agri-food Research Fund through several RandD projects and technology transfer, all aiming to fight ND and develop the activity. Other organisations or associations like PAFFA, HEIFER, ENDA, etc. are engaged in accompanying the development of rural poultry farming. Thus, according to the official document of the Ministry of Economy and Finance, September 2011: «Economic and Financial situation in 2011 and perspectives in 2012», traditional poultry farming is one of the sectors targeted in livestock development.

Materials and method

Materials

• Infrastructure
  A well-equipped chicken house with ensured biosecurity is used for poultry farming to produce embryonated eggs.

• Animals
  A Minimum Disease Flock (MDF) of 90 chickens, laying chickens and 20 cocks are reared in a house with good biosecurity to produce eggs used for the production and quality control of I-2 vaccines.

• Products
  I-2 vaccine and PROMECTIN®

Method

• Vaccine production
  Depending on the need, the I-2 vaccine (I-2 strain provided by Prof. Spradbrow through FAO), is produced in the vaccine production laboratory as liquid and freeze-dried vaccine. Vaccination
sessions and deworming are conducted on the flocks in the targeted villages. To confirm the efficiency of the vaccine, serological analysis is performed on blood taken from chickens before and after vaccination.

- Analysis

Serological analysis is undertaken on the samples at the laboratory and the results are compiled using ‘Access’ software and statistical analysis (average and standard deviation) using Excel.

**Results and discussion**

**Management of a biosecure flock for the production of MDF fertilised eggs**

In 2011 a former livestock building was renovated and upgraded to become a functional chicken house with ensured biosecurity. The choice of using local source eggs (MDF) is to avoid shortages of SPF eggs supply. The building has feed storage, farming equipment and a breeding place. Access to the breeding room is subject to entry through three consecutive rooms: the first room to undress, followed by the shower room and another room to don gown or overalls and work boots, finally to the breeding room. The floor and the interior walls are made of tiles. The room is fitted with air extractors and the ventilation openings are covered with mosquito netting.

The chicks, the future laying hens and cocks were produced from imported SPF eggs that were placed in incubation at the vaccine production laboratory. These were raised in two mobile boxes divided into two cages each. Each cage has a capacity of 25 birds. In practice, there are 20 hens and 2 cocks per cage, or a total of 80 hens and 8 cocks.

The average egg laying rate was 80 ± 2% with a peak of 95%. The fertilisation rate was 82 ± 4%. However, the hatching rate for the replacement of the flock in the first generation is low: 47 ± 3%. This can be explained by the fact that it was not deemed important to differentiate the feed given to the hens and cocks, due to the low flock size. Thus, the cocks were consuming the same amount of feed as the laying hens and hens, and this may affect the fertility of the cocks. In addition, we are planning to renew the population with chicks hatched from SPF eggs.

![Figure 1. View of biosecure chicken house (Traoré 2011)](image)

**I-2 vaccine production - wet and freeze-dried**

The vaccine is produced in the laboratory where the freeze-dried vaccines are produced and access is limited to authorised technicians only. The usual production practices are performed including the use of a bio-decontaminator, a device that allows total sterilisation of the atmosphere. The option of producing the two types of ND I-2 vaccine is to enable our production unit to meet the national and international demand efficiently and effectively. Thus, the freeze-dried vaccine, which is more difficult to produce and costly will be destined for export; whereas the wet one, more convenient and less difficult to produce and use, will allow the laboratory to meet the pressure of the local needs quickly.
To test the effectiveness of the vaccine, pre- and post-vaccination blood samples were taken from chickens located in two different sites, at Thiéyi in Diourbel and Mbadkhoun in Kaolack region. The Geometric Mean Titer (GMT) revealed that 98% of the chickens were not protected before vaccination. Then, the flocks of the two villages were vaccinated.

After three weeks and one month, sampling was carried out in the same sites to verify the effectiveness of the vaccine. After analysis, the rate of vaccination coverage (vaccinated birds with an HI titre that is assumed to indicate protection in the face of an outbreak) was found to be 98% in Thiéyi and 80% in Mbadkhoun. The chickens are thus immunised and protected because, according to the law of Charles Nicolle: 'to control a disease well, there should be at least 80% vaccination coverage'. Furthermore, I-2 virus spreads laterally, so it is evident that the flock population of these areas is protected against ND. So, this shows that the vaccine is effective and will serve to combat ND at national level.

**Figure 2.** Session of blood collection (Sall 2011)

**Some results of mass vaccination against ND associated with deworming.**

A vaccine trial using I-2 was conducted on 740 local chickens in the three villages located in the three departments of St. Louis region (Table1). Prior to vaccination, a census was conducted and the total number of chickens was 740, with an average flock size of $11.91 \pm 4.69$ per farmer among the poultry farmers identified (Table 1). The first phase vaccination was undertaken during the month of November 2010 using I-2 vaccine and deworming was conducted using Ivermectin (PROMECTIN®). The second phase and third (last) phase were undertaken using the same poultry flocks in March and July 2011 respectively.

The assessment of the effect of the vaccine and deworming performed after one year of vaccination has shown that the total number of chickens has reached 1,587 that is $25.59 \pm 6.76$ chickens per farmer (Table 2). The comparison of their number after vaccination and deworming to that before vaccination and deworming shows that the number has been multiplied by 2.14. After vaccination and deworming the flock is mainly composed of chicks and young chickens, which proves that the increase is due to births during the year, confirming a decrease of mortality.
**Table 1.** Number of flocks surveyed before vaccination and deworming

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<th>Other types of birds</th>
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<td>Kowori</td>
<td>7</td>
<td>25</td>
<td>30</td>
<td>21</td>
<td>0</td>
<td>76</td>
<td>10.85 ± 2.54</td>
</tr>
<tr>
<td>Fanaye</td>
<td>17</td>
<td>63</td>
<td>96</td>
<td>28</td>
<td>49</td>
<td>236</td>
<td>13.88 ± 13.58</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>262</td>
<td>248</td>
<td>138</td>
<td>92</td>
<td>739</td>
<td>11.91 ± 4.69</td>
</tr>
</tbody>
</table>

Source: Taousset 2011

**Table 2.** Number of flocks surveyed one year after vaccination and deworming

<table>
<thead>
<tr>
<th>Village</th>
<th>Number of farmers</th>
<th>Chicks</th>
<th>Hens</th>
<th>Cocks</th>
<th>Other types of birds</th>
<th>Total number</th>
<th>Average per farmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keur Gora D</td>
<td>6</td>
<td>116</td>
<td>44</td>
<td>22</td>
<td>27</td>
<td>209</td>
<td>34.83 ± 19.41</td>
</tr>
<tr>
<td>Wouro Saer</td>
<td>9</td>
<td>79</td>
<td>57</td>
<td>21</td>
<td>0</td>
<td>157</td>
<td>17.44 ± 7.21</td>
</tr>
<tr>
<td>Ndélé</td>
<td>23</td>
<td>263</td>
<td>116</td>
<td>81</td>
<td>39</td>
<td>499</td>
<td>21.69 ± 14.19</td>
</tr>
<tr>
<td>Kowori</td>
<td>7</td>
<td>95</td>
<td>70</td>
<td>33</td>
<td>0</td>
<td>198</td>
<td>28.28 ± 13.47</td>
</tr>
<tr>
<td>Fanaye</td>
<td>17</td>
<td>76</td>
<td>195</td>
<td>167</td>
<td>86</td>
<td>524</td>
<td>30.82 ± 32.36</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>629</td>
<td>482</td>
<td>324</td>
<td>152</td>
<td>1587</td>
<td>25.59 ± 6.76</td>
</tr>
</tbody>
</table>

Source: Taousset 2011

**Training farmers to vaccinate and deworm**

Training workshops addressing the technicians of the Agricultural Council and poultry farmers regarding techniques of managing I-2 vaccine, deworming using PROMECTIN and poultry farming were organised in several villages including St. Louis Diourbel, Kaolack and Kaffrine. More than 70% of the participants were women and children.

![Image](image1.jpg)

**Figure 3.** Vaccination and deworming sessions (practical demonstration) (Sall 2010)

**Conclusion**

The ND vaccination sessions together with deworming have allowed the rural poultry farmers to understand the importance and need of protecting their flocks against the disease. However, after ND vaccination, fowlpox disease appeared in several villages. That is why future poultry mass vaccination should comprise vaccination against ND, fowlpox and deworming. The vaccine production laboratory has worked on the development of an oral form of vaccine, easier for farmers to administer than the one given by wing stab.
A lot of projects aiming at developing village poultry and extending efficient farming methods to a larger scale have started to be financed in Senegal. However, consideration should be given to the establishment of an SPF egg production unit at continental level to satisfy the needs of African vaccine production laboratories.

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Newcastle disease situation in the Sudan
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Sudan

Introduction
The Sudanese poultry industry ranges from small backyard flocks owned by households to large enterprises. The poultry industry developed significantly in the past five years. The total chicken population in the country is about 55 million, of which 30 million are kept under the traditional system of poultry production. Traditional poultry production is still an important system of poultry production in the villages and towns of the Sudan. Local chickens are indigenous breeds living in symbiotic relationship with human communities. Adult birds are of medium size with an average body weight of 1.3-1.4 kg and egg production of 40-50 eggs per year. In this system chickens are left to look for their own food and only given small amounts of grains and kitchen leftovers. The average flock size is 19 and the birds are kept in overnight housing. Most of the flocks are owned by women who are responsible for feeding and cleaning.

Newcastle disease (ND) situation in the Sudan
The major disease problem affecting traditional poultry production is ND with prevalence rate of 30%. The mortality rate due to the disease ranges between 40 and 96%. The disease is endemic in the country. The rural areas are heavily affected by the disease but reports from rural areas are very rare. The Poultry Diseases Department of the Veterinary Research Institute (VRI) reported 12, 11, 4 and 12 outbreaks in the years 2012, 2011, 2010 and 2009 respectively, coming mainly from poultry farms in towns.

ND vaccines produced in VRI
- Komarov: produced in 1963; the most effective and widely used vaccine. It is a live vaccine given intranasally to chicks at 4 weeks of age and repeated when the birds reach 4 months old.
- La Sota: produced in 2005; a live attenuated vaccine given to chicks at 21 days of age in drinking water.
- Killed ND vaccine (formalin): produced in 2012 and given as a subcutaneous injection to day old chicks.
- I₂ thermostolerant vaccine: produced in 2012 to be given to local birds as eye drops when the chick is 10 days old. The I₂ thermostolerant vaccine was tested in the field and found to be safe and protective. It can be produced in the lyophilised form.

Live ND vaccines produce the best immune response irrespective of the vaccination route, and all the live ND vaccines produced in the Sudan are safe, immunogenic and protective.

Some large enterprises are branches of large foreign companies who have their own vaccination protocols and import their own ND vaccines from the mother companies.
Veterinary Research Institute (VRI)

Central veterinary research institute centres
1- Atbara: Dongola
2- Kassala: Elgadarif+ Port Sudan
3- Sinnar: Damazine+ Rabak+ Madani
4- Elobied: Kadugli+ Abu Jibalha+ Elfula
5- Nyala: Elfashir+ Radom+ Elginana

Regional laboratories centres
Country report Tanzania
Dr Halifa Msami
TVLA
Tanzania

Introduction
Poultry products are among the most important protein sources for humans throughout the world (FAO). Twenty percent of animal protein intake in Tanzania as well as other African countries originates from poultry. Poultry keeping (especially in villages) is seen as a major activity which contributes to the improvement of the local rural majority. Throughout Tanzania, most people in rural areas keep small flocks of village poultry (average 5-20 birds), often owned and managed by women and children. Rural poultry are important in meeting economic and social obligations for households, especially in poor families where they play a role in poverty alleviation and improvement in food security. They are used for home consumption and income generation, provide manure and are active in pest control. Village poultry improvement programs have the potential to contribute to the National Strategy for Reduction of Poverty (MKUKUTA) and MDGs broad outcomes. Also, individuals affected by diseases such as HIV and AIDS find chicken-raising an easy activity that can contribute to household food security and income.

Transboundary animal diseases
Common transboundary animal diseases (TADs) in Tanzania include contagious bovine pleuropneumonia, rabies, foot and mouth disease and contagious caprine pleuropneumonia. Others are Newcastle disease (ND), lumpy skin disease, and African swine fever. TADs are notifiable requiring urgent action. National, regional and international cooperation is necessary in the control of TADs through an enhanced system of early warning, early detection, coordination and harmonisation of control strategies. The Southern African Development Community (SADC) has identified measures to manage the risk of TADs which include the prioritisation and targeting of diseases to ensure proper management, development of clear surveillance and control protocols and training of farmers and field staff.

The Tanzanian policy statements on TADs are
- The Government will strengthen technical support services for TADs control and eradication.
- The Government in collaboration with other stakeholders will encourage and promote investment in production of veterinary vaccines and other inputs.
- The Government will strengthen infrastructure for control of TADs.
- Efforts will be made to harmonise national and regional policies on TADs.

The control of TADs is constrained by inadequate animal health support services, inadequate infrastructure, a weak private sector, high cost of vaccines and inadequate knowledge on TADs among stakeholders.

Control of ND in Tanzania
ND is a major problem in the development of village chickens as it causes a high mortality rate (up to 90%) and sometimes devastates whole flocks during outbreaks. Control of ND in village chickens in the past had very limited success as most of the vaccines used were heat sensitive and supplied in vials containing a large number of doses and were not affordable for most rural
farmers. Also the vaccines were thermolabile requiring a cold chain system for their distribution. This is lacking or deficient in most rural areas. This obstacle has recently been overcome through the development of a thermostolerant ND vaccine I-2 that was developed in Australia and is extensively used in Tanzania. Administered by eye drop, the I-2 vaccination techniques are easy, effective and sustainable. I-2 vaccine can be kept outside the refrigerator for up to three weeks and is available in droppers containing a small number of doses.

For three years (2002–2005) and more recently (2009-2013), the Southern Africa Newcastle Disease Control Project (SANDCP) and Regional ND Control Project respectively, implemented a community-based ND control model. The two projects produced and tested both the vaccine and extension materials. The projects focused on an integrated program encompassing institutional strengthening of the Government Livestock sector and NGOs, and promoting rural community participation and ownership in the sustainable ND control model. The pilot efforts have had a resounding success. As a result Tanzania is now doing well in the control of ND in village chickens and continuing to produce and use increasing amounts of I-2 ND wet vaccine. However, the demand for expansion of the service is proving to be a great challenge. Currently NGOs, CBOs, the private sector and government delivery systems in many districts are under-performing. The Government of Tanzania is working towards augmenting the performance of various actors in the control of ND by a proper coordination of their activities. The Government efforts involve scaling up of the effort to more pilot communities in several regions throughout Tanzania.

Thermotolerant I-2 vaccine against ND is now manufactured in Tanzania. It is simple to administer and effective against the disease. Village poultry keepers recognise the vaccine as the most important input to increase production and productivity of their poultry. However, a proper vaccination strategy for controlling the disease in village poultry flocks is lacking in most local government authorities.

**ND control achievements in Tanzania**

- Capacity building in training
- Comprehensive ND control extension package has been produced and adapted for use in the country
- Successful collaboration with stakeholders: LGA’s, NGOs, village communities and politicians
- Successful implementation of a community-based ND control model using I-2 ND vaccine
- Sustainable ND vaccine production at TVI and distribution throughout the country
- It has been shown that control of ND in village poultry will only be effective through area-wide vaccination campaigns at the community or district level.
Challenges

- The control of TADs is constrained by inadequate animal health support services, inadequate infrastructure, a weak private sector, high cost of vaccines and inadequate knowledge on TADs among stakeholders.
- The challenge is to educate stakeholders about the use of the vaccine, and to set up a sustainable manufacturing and distribution network to those areas where vaccine is most needed.
- Need to develop new training materials and methodologies to respond to challenges emerging following the control of ND.
- Research required strengthening village poultry value chain.
- It has been shown that control of ND in village poultry will only be effective through area-wide vaccination campaigns at the community or district level.

Major Constraints

- Emerging diseases and high chick mortality especially fowlpox
- Lack of chicken houses, predation
- Nutritional deficiency (particularly vitamin A)

Initiatives and way forward

- The target is to produce 105 million doses of I-2 per year
- Organise programed vaccination campaigns (the Southern highlands are already vaccinating 3.5 million rural chickens per campaign)
- Improve delivery and vaccine distribution - cold chain facilities especially at LGAs
- Improve vaccine production efficiency and quality control
Newcastle disease and poultry production in Zambia
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Central Veterinary Research Institute,
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Introduction
During the 2010/2011 post-harvest survey conducted by the Central Statistical Office (CSO) through the Agriculture and Environmental Statistics Branch of the small and medium farmers, an estimated number of 838,252 poultry farmers was recorded during the 2010/2011 agricultural season. Different farmers raised poultry for different purposes such as meat, eggs, feathers, aesthetic value and others. According to the information collected, about 694,261 (82.8%) farmers raised poultry for meat and 49,073 (12.8%) farmers raised poultry for aesthetic value. Rural poultry production is an important agricultural activity in Zambia, contributing to household nutrition and food security by providing a reliable source of protein in the form of meat and eggs. Chickens and eggs are also sold for cash or bartered for necessary household items such as school supplies, cooking oil, and medicine, thus significantly contributing to overall family welfare in rural areas.

Village chicken raising in the 2010/2011 Agricultural Season was reported in all the provinces of Zambia. An estimated 10,490,492 village chickens were raised by 30th September 2011 compared to 14,100 that was reported on 1st October 2010. The Southern Province is reported to have raised 2,258,464 village chickens by 30th September 2011, accounting for the highest number of village chickens raised at 21.5% followed by Northern Province with 18.5%. Lusaka Province with 443,588 village chickens was the least accounting for 4.2% of the total village chickens raised at the end of the season. The value of proceeds from sales of village chickens in the 2010/2011 agricultural season was estimated at KR25 million (about US$4,500,000). At the end of the season, Northern Province recorded the highest number of village chicken sales value which accounted for 18.8% of the total sales value followed by Southern Province with 17.6%. Lusaka Province was reported with the least sales value which accounted for 4.4.

Newcastle disease (ND) is a highly infectious viral disease affecting both domestic and wild avian species, with up to 100% case fatality, which poses a severe constraint to rural Zambian poultry production.

Epidemiology of ND
The disease was first reported in native fowls in Zambia in Mazabuka district, 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.

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.

Cases of ND in chickens occur throughout the year and all the 12 provinces of Zambia have reported this viral disease in chickens in the past. Although reports come in all year round there is a 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.

**Challenges in ND control**

**Confirmatory diagnosis**
The diagnosing of ND through clinical signs as well as through post-mortem findings without the submission samples to confirm the disease has made it difficult to know whether or not village chickens get infected or die of ND. Clinical signs and post mortem findings only do not present a reliable basis for diagnosis of ND. Morbidity and mortality depend on virulence of the virus strain, degree of vaccinal immunity, environmental conditions, and condition of the flock. Samples should be submitted to the laboratory for confirmation.

**Lack of monitoring and surveillance of ND**
This poses a big problem in the co-ordination of activities and ultimately leads to not having sufficient information needed for future planning so that ND is brought under control. This maybe has led to having insufficient information needed to highlight the importance of ND to the chicken farmers and other stakeholders.

**Electricity power cuts**
This can adversely affected the quality of the vaccine produced at Central Veterinary Research Institute (CVRI) and vaccination programs in the field may not yield the desired results.

**Opportunities**
The development of the I-2 Newcastle vaccine at the CVRI in Zambia through the support from KYEEMA Foundation, poultry farmers in Zambia will have access to a vaccine which does not require the cold chain facilities. This is likely to improve the vaccination coverage in the country.

The government of Zambia has is providing funds for ND activities at CVRI so that poultry farmers especially those keeping village poultry can have access to the thermotolerant vaccine.

Sustainability of ND activities is assured because of the existing revolving fund at CVRI which has been so helpful when government funding has been delayed or even not made available at all.

Registration of the I-2 Newcastle vaccine is expected soon because all the data the Pharmaceutical Regulatory Authority wants is available. Farmers will soon start accessing this vaccine.

**Diagnosis of ND**
For a definitive diagnosis of ND, both virus isolation and laboratory characterisation are necessary. Nevertheless, if the disease is known to be present in a given area, signs and lesions may be considered highly suggestive, especially for village chickens. Typical clinical signs are: a state of prostration and depression in the birds, with ruffled feathers; greenish white diarrhoea; and, in survivors, the head turned to one side, a condition known as torticollis is very often seen, as are paralysis of the legs, wings or other neurological signs. Other typical characteristics of the disease include: rapid spread; death within 2-3 days; a mortality rate of over 50% in naïve populations; and an incubation period of 3-6 days or, on rare occasions, 2-15 days (Beard and Hanson 1984). On necropsy, typical lesions are mucus in the trachea, and usually haemorrhages in the intestine, particularly in the proventriculus. It should be borne in mind that all the preceding signs and lesions can be caused by other diseases.
Clinical signs alone do not present a reliable basis for diagnosis of ND. Morbidity and mortality depend on virulence of the virus strain, degree of vaccinal immunity, environmental conditions, and condition of the flock.

**Laboratory diagnosis**

For a definitive diagnosis of ND, both virus isolation and laboratory tests are necessary. Two methods are used to measure antibody titres: the enzyme-linked immunosorbent assay (ELISA) and the haemagglutination inhibition (HI) test. These can be done at Central Veterinary Research Institute. Some members of staff at CVRI have been trained in the haemagglutination and inhibition technique by the KYEEMA Foundation.

**Control strategies**

It is a statutory requirement that all suspected cases of ND be reported to the office of the Department of Veterinary Services. 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. The commercial hatcheries vaccinate day-old chicks using imported vaccines by intranasal or eye drop routes. Farmers are advised to revaccinate boilers at 7 and 21 days with La Sota. Layers are revaccinated at 10 weeks of age.

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 condyocarpon, Droogmansia pteropus, Swartzia madagascariensis, Euphorbia tinnarii, Ficus species, Imulia glomerata, Isoberlinia angolensis and Kigelia africana.

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Overview of the Zimbabwean agricultural sector

Charles Guri
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Introduction

The Republic of Zimbabwe is located in Southern Africa and shares borders with the following countries: Zambia to the north, Mozambique to the east, the Republic of South Africa to the south, Botswana to the south west and Namibia to the west. Total land mass is 390 580 km². The country is divided into five agro-ecological zones, Natural Regions (NR) I, II, III, IV and V based on rainfall with annual average rainfall of 640 mm.

According to Zimstats estimates of 2009, Zimbabwe has an estimated population of 11.35 million, 65% of which is rural and 35% urban. As the economy of Zimbabwe is agro-based 37% of GDP is derived from agriculture. Agriculture is the major employer with 25% of the population directly employed and 35% indirectly employed in agriculture.

Of the rural population 70% are small holder farmers and derive their livelihoods on agriculture. The smallholder farm (SHF) sector comprises the small-scale commercial farming sector, the old resettlement sector, the communal sector and lately, the A1 resettlement farming sector. Average land holdings in the communal and old resettlement areas vary from 2.8 to 5.0 ha per household depending on Natural Regions (NR) with higher hectarage generally in marginal areas of NR III, IV and V.

Crop production is the major farming activity within the smallholder sector. Livestock production is often thought to play a complementary role to cropping. In a local study it was realised livestock production contributes more to general farming in NRs III, IV and V than in NRs I and II (Chawatama et al. 2005). In these semi-arid regions prone to droughts, households rely on exchange of livestock for grain as livestock farming is the only sustainable farming activity.

Approximately 55% of households in communal farming areas own cattle, more than 70% own goats and over 80% have chickens (DVS 2009). Several studies in Zimbabwe have indicated that livestock are an integral part of the smallholder farming system through the provision of draught power, both tillage and transport, manure, milk, meat and eggs and their role in socio-ethnic practices. Small ruminants (goats and sheep) and non-ruminants, particularly poultry, are also an important source of livelihood in the smallholder sector and play a complementary role to that of cattle. A large proportion of the farmers rear small stock for home consumption, as opposed to cash generation (Tawonezvi 2005).

Despite the perceived benefits and value of livestock, both production and productivity have remained low particularly in the small holder sector. Several constraints still exist in small holder livestock production such as disease, lack of reliable extension services and poor marketing systems. The situation has been compounded by under-funding of livestock activities by government and donor agencies in favour of emergency relief and mitigation programs targeting crop production (FAO 2010).

However opportunities have arisen in the livestock sector particularly small stock as they have been found to withstand droughts, recovery is also faster after droughts and they are easy to liquidate in times of need. The unpredictable economic environment that prevailed in the
greater part of the last ten years has also largely favoured the rearing of small stock especially poultry. Thus small stock, principally poultry are expected to play an increasing role in household food security and livelihoods, particularly in the semi-arid regions which account for more than 65% of national land area, where farmers’ livelihoods are largely dependent on livestock marketing.

**Opportunities and challenges in the livestock sector**

The agricultural production system in the SHF sector is predominantly subsistence. Tawonezvi (2005) observed that a large proportion of farmers rear small stock for home consumption, as opposed to cash generation. Livestock in this sector contribute significantly to the socio-economic development and livelihoods of the local rural population as described above. SHF sector livestock and products are mainly sold through informal markets although in the recent past there has been a deliberate drive towards establishment of formal markets.

Small livestock are mainly reared to cover day to day expenses such as grocery items or bus fares, as they can easily be liquidated to meet small household expenses. They also provide variety to diets and are the major protein source for vulnerable smallholder farmers. Manure from small livestock is valued more than that of cattle due to its relatively higher quality and it is often used as organic fertiliser in vegetable gardens and is also an important source of petty cash for SHF.

Recent findings indicate that goats and chickens are increasingly being slaughtered at funerals, in place of cattle, highlighting their increased role in socio-cultural functions and perhaps, suggesting a shortage of cattle. Of the small livestock, chickens’ importance has grown. Chickens are also used as a medium of exchange in rural trading. Most households exchange chickens for grain especially in districts prone to droughts in the semi-arid NR III, IV and V. The importance of backyard poultry cannot only be restricted to rural households as there is general consensus that the village chicken is tastier and healthier. This has resulted in village chickens finding a ready market in urban areas especially in restaurants that serve traditional dishes.

A 2006 study by Aboe et al. across Africa showed households had an average of 16-33 birds per flock and the predominant providers of care for these chickens were women and children. A local study also showed that the average backyard flock was composed of 20 birds, that is, 8 chicks, 6-7 growers, 4-5 hens and 1 cock. Women owned most of the chickens at a homestead and they could make independent decisions on management and even disposal without consultation. Most of the chickens owned were the village-type. Very few farmers reared commercial broilers and layers because they demanded a large initial capital outlay. In addition, the market for broilers and eggs is usually poor in rural areas and it is also difficult to access the urban market due to low volumes (Oakeley 1998).

As with other livestock production systems, several constraints still exist in small holder chicken production such as disease, lack of reliable extension services and poor marketing systems. Newcastle disease (ND) was singled out as the most important disease because it is prevalent in most areas and has the potential to wipe out entire flocks (FAO 2010). The lack of a consistent vaccination program due to underfunding has consequently increased ND outbreaks. ND outbreaks in the country affect mainly the rural backyard chickens. Commercial farms have resources and ND is under control as the farmers are able to vaccinate their chickens resulting in fewer outbreaks. Studies in West Africa, Ghana (Aboe et al. 2006), Cameroon (Bell et al. 1995) and Nigeria (Adu et al. 1990) show that ND contributes between 77% and 80% to
poultry losses. A study in neighbouring South Africa (Thekiso et al. 2004) indicates that ND accounts for 70-80% of losses in village chickens, a situation which simulates local conditions.

To conclude, a meaningful intervention in agriculture should target the livestock sector as it is least affected by droughts and tends to recover quickly following droughts. Within the livestock sector interventions targeting small stock, particularly poultry, would benefit 1 million vulnerable households thus resulting in significant progress towards attainment of food security and sustainable income generation. The increased production will not only result in improved nutrition for the farmer but the benefits will extend to the national economy, as will be explained. Should this intervention be attempted ND control will remain key and guarantee the success of this intervention. ND remains the major constraint in backyard poultry production as up to 80% of losses in this sector are due to the disease. Control of ND in sub-Saharan Africa will result in increased household income and the implementation of sustainable control measures is of utmost priority.

The poultry sector and the ND situation: past and present

The economic impact of the poultry industry to global and national economies is significant. In Zimbabwe more than 60% of animal protein consumed by the human population is sourced from poultry and its products. More than 80% of Zimbabwean farmers own chickens. ND is classified as a notifiable disease in Zimbabwe mainly because it is the most significant disease of economic importance in the poultry industry.

To demonstrate growth of the local poultry industry the total turnover of the poultry industry (formal and informal) has increased from $39 million in 2009 to $114 million in 2010 and $158 million in 2011. This growth can not only be attributed to the large scale commercial producers as it is estimated that more than half of day-old chicks produced by licensed breeding companies, are sold to small-scale poultry producers. In 2011, only 35% of chicks produced were slaughtered by large-scale abattoirs, suggesting that the remainder of the chicks entered the small-scale and informal sectors. There has been a phenomenal growth in small scale poultry farmers and the majority are backyard producers. Current poultry population estimates stand at 45 million with backyard producers raising just over 11 million birds and contributing significantly towards the GDP.

Possible reasons for this tremendous growth are the high unemployment rate, the quick returns from investment in poultry and the nature of the broiler industry. The poultry sector has small capital requirements, easy entry, easy exit, a short production cycle, minimum space requirements and the enterprise can fit in well in the social set up. This has however brought additional challenges to ND control.

Zimbabwe was free of ND until 1986 when outbreaks occurred in Southern Africa. Subsequently infection spread to all areas of the country due to uncontrolled movement of chickens. ND outbreaks in the country still affect mainly the rural backyard chickens and of late have occurred in areas where there is no vaccination. ND in commercial farms is under control as they follow routine vaccination protocols and scheduled inspections are done by the Department of Veterinary Services. However village and backyard chickens still pose most risk for outbreaks and threaten exports.

ND was then classified as a specified animal disease, that is, control of the disease was regulated through the Newcastle regulations which stated; among other things

- It is a legal requirement to report any suspected ND outbreak to veterinary authorities immediately.
All ND outbreaks are controlled by government through DVFS. Vaccination became the primary method used to control ND.

The Central Veterinary Laboratory (CVL), an arm of the Division of Veterinary Technical Services (DVTS) was tasked with vaccine production and provision of technical backup to field staff, namely pre- and post-vaccination monitoring. The CVL also has the equipment and personnel to diagnose ND through serological, pathological and PCR diagnostic methods. The Division of Veterinary Field Services (DVFS) is responsible for provision of extension services, material, vaccinations and training of Community Based Vaccinators (CBVs).

Before the turn of the century the DVS was able to reduce the number of outbreaks through countrywide mass vaccination programs of flocks primarily as a means of control and eradication. Prior to 2005 the department reacted to outbreaks by mobilising vaccination teams from its staff members who would go from door to door vaccinating chickens.

With the introduction of the land reform program and withdrawal of funding by development partners post 2000, DVS faced challenges in ND control. Constraints included but were not limited to lack of transport, operational funds, changed demographics in the livestock sector due to the land reform program, and lack of reliable monitoring and evaluation tools.

ND outbreaks that occurred in the past decade are shown in Figures 1 to 6. The graphs and maps indicate a high prevalence before vaccination and reduced incidence during the years of vaccination. Epidemiological evidence indicates that most outbreaks occur during the dry/ winter season in the northern provinces with a few outbreaks occurring in southern Zimbabwe.

![Graph showing Newcastle Disease outbreaks from 2001 to 2006](image)

**Figure 1.** ND outbreaks from 2001 to 2006
Figure 2. ND outbreaks 2001-2004

Figure 3. Map of Zimbabwe showing the achievements of previous vaccination campaigns
Figure 4. ND outbreaks 2009

Figure 5. ND outbreaks 2010
**Figure 6. ND outbreaks 2011**

To fill the gap ND control projects were run in conjunction with HPAI awareness, sponsored by FAO in collaboration with the department. The CBV concept was also initiated in 2005 through such projects to overcome extension challenges and has been hugely successful.

However there were still several challenges including inadequate budget for vaccine production and operational funds for vaccination campaigns, brain drain resulting in staff shortages particularly extension staff and loss of experienced laboratory staff. In addition CBVs and extension staff did not find the wet form of I-2 user friendly and in-transit and field losses were therefore significant.

In 2011 DVS was granted funds by the EU through AU-IBAR VACNADA project towards ND control in high ND prevalence provinces. The project allowed Zimbabwe to use freeze-dried vaccine for the first time and establish capacity towards freeze-drying the locally produced I-2 vaccine. Over 600 extension staff were trained to train about 22 000 Community Based Vaccinators in the use of freeze-dried I-2 vaccine.

The major highlights of the Zimbabwe VACNADA project were:

- Achievement of greater vaccination coverage through collaboration with other development partners such as FAO and PLAN in ND control.
- Capacity to produce freeze-dried I-2 vaccine at CVL which will result in improved vaccine quality and realisation of advantages associated with use of the freeze-dried form of I-2 vaccine.
- The decentralisation of serology tests through the provision of basic ELISA equipment to provincial laboratories which has greatly enhanced the department’s diagnostic capacity.
- The participation of women and youth in CBV trainings was encouraging as they are the custodians of poultry. This could indicate a high level of project ownership.
To sum up, the lessons learnt include:

- Future projects should adopt an integrated approach, incorporating all aspects of poultry husbandry including marketing and market linkages, to maximise outputs from ND control.
- Synchronisation of cross border vaccination of ND particularly with Mozambique would be of mutual benefit to both countries as cross border trade plays a major role in ND epidemiology.
- CBVs and extension staff generally found freeze-dried ND I-2 vaccine user-friendly and the production of 100 or 200 doses would be convenient to the farmer especially the SHF. The adoption of the vaccine freeze-drying technology at the CVL would enable extension staff and CBVs to use a more user-friendly I-2 vaccine.

Ultimately, maintaining control of ND in backyard flocks will depend on the involvement of the farming community. Farmer enthusiasm in previous campaigns reflects the level of priority they give the disease as over 11 million birds were vaccinated in the last campaign. It appears that the skills are being readily transferred to producers, catching birds is not a problem, and that subsequent vaccinations will be handled by producers themselves, with only limited input from veterinary staff allowing for a more sustainable ND control program. This is also revealed by the overwhelming response as over 80,000 CBVs were trained. Despite the evident variation in backyard flock productivity, the majority of extensive producers surveyed claimed to have no support or contact with the formal veterinary and extension services. Thus there is still need to reinforce existing veterinary extension services to allow greater coverage.

It can be concluded that ND is still an important disease affecting poultry in Zimbabwe. The major shortcoming of previous vaccination campaigns has been inconsistent or no vaccination due to the above-mentioned challenges. However farmer support, the prevailing macro-economic climate, existing infrastructure and human resources can result in the implementation of a sustainable ND control program.

**ND control a sustainable solution to SHF empowerment**

Stagnation of the smallholder agricultural sector has been noted as a ‘key underlying constraint to agricultural growth and recovery’ (UNDP 2008:158). Thus current production status, constraints and opportunities for development, in order to guide policy makers and funding institutions on viable areas of investment have already been identified in Zimbabwe. As such investment in the SHF had to be prioritised.

As outlined in the introduction, livestock production particularly small stock in the SHF is expected to play a leading role due to climate change. Persistent droughts since 2000 have negatively affected crop production and consequently affected cattle production. The lack of grazing, water and loss of genetics due to destocking exercises and the advent of Conservation Agriculture (CA) have been noted as major challenges to cattle production. Small stock, in particular poultry have been identified as a feasible solution towards resuscitation of SHF livestock. However ND control is the initial step towards achieving set goals.

The trend towards diversification from cattle to small stock can be explained by their apparently greater ability to withstand drought conditions and because small livestock herds or flocks generally tend to recover more rapidly after droughts. Chickens and pigs in particular have been promoted as they do not place an additional burden on the grazing resource and they complement Conservation Agriculture. They have also been observed to play an increasing role...
in household food security, particularly in the semi-arid regions where farmers’ livelihoods are largely dependent on livestock marketing for their livelihoods.

As 80% of these farmers own chickens and the chickens are owned and managed predominantly by women a meaningful intervention could only be achieved through a support program targeting this vulnerable group. The major challenge in poultry production in the SHF sector is ND. A sustainable ND control program with national coverage is required to address the above problem and possibly transform the poultry production system in the SHF sector from subsistence to income generation.
Supporting food security and capacity building in African Union member states through the sustainable control of Newcastle disease in village chickens

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2Faculty of Veterinary Science and the Charles Perkins Centre, University of Sydney.
3African Union Pan African Veterinary Vaccine Centre, Debre Zeit, Ethiopia.

Introduction

Food security is a global priority requiring an interdisciplinary approach. Despite increases in agricultural production over the past two decades, undernutrition rates in children have not diminished significantly in many developing countries. Additionally, available data indicate that gender inequality and cultural issues have been inadequately addressed in most research linking agriculture and nutrition. Undernutrition is a result of complex causes and to date little research has examined nutrition-specific, health-based approaches in collaboration with food system and livelihood-based interventions. Crucially, supplying women of childbearing age and their children with sufficient calories is important but it is not enough to optimise epigenetic programming; the proper balance of micronutrients is also essential for both short- and long-term health. Nutritional insecurity can result in stunting which is caused by chronic under nutrition. Stunting affects health, physical and cognitive development capacity in children as well as productivity in adulthood.

Family poultry are the most commonly owned livestock in the world. They comprise extensive and small-scale intensive poultry production and are still important in Africa, Asia, Latin America and the South Pacific (Table 1). Family poultry remains critically important with estimates suggesting that more than 80% of the world’s poultry stock is kept in small numbers, from as few as three up to about 20.

Family poultry have a special place as they require low investment, assist with pest control, provide manure for fertiliser, and contribute to both poverty alleviation and food security. Importantly, poultry are frequently the only livestock under the control of women, and improvements in their production can also strengthen women’s status in the household and in the community by increasing their social standing and their financial autonomy.

Village poultry improvement programs have the potential to contribute to each of the MDGs, see Table 2.

Food and nutrition security

Family poultry have a special place in food security as they are owned by between 70 and 99% of households in many rural communities and are frequently the only livestock under the control of women. They require low investment and can contribute significantly to both poverty alleviation and food security. Newcastle disease (ND) is considered the most important poultry disease worldwide and a model for its sustainable control in family poultry is now available. Improved family poultry production can increase nutritional outcomes directly by providing meat and eggs and indirectly by providing cash income to purchase food. Poultry meat and eggs provide high quality protein and micronutrients (e.g. zinc, vitamin A and iron), which provide wholesome nutrition and are important for child growth. These benefits are also of notable significance to
vulnerable community members such as growing children, pregnant women and people living with HIV.

Table 1. Characteristics of the four family poultry production systems (Thieme et al. 2014)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Small extensive scavenging</th>
<th>Extensive scavenging</th>
<th>Semi-intensive</th>
<th>Small scale intensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production/ farming system</td>
<td>Mixed, livestock and crops, often landless,</td>
<td>Mixed, livestock and crops</td>
<td>Usually poultry only</td>
<td>Poultry only</td>
</tr>
<tr>
<td>Other livestock raised</td>
<td>Seldom</td>
<td>Usually</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Flock size</td>
<td>1-5 adult birds</td>
<td>5-50 adult birds</td>
<td>50-200 adult birds</td>
<td>&gt; 200</td>
</tr>
<tr>
<td>Poultry breeds</td>
<td>Local</td>
<td>Local or crossbred</td>
<td>Commercial or crossbred</td>
<td>Commercial</td>
</tr>
<tr>
<td>Source of new chicks</td>
<td>Natural incubation</td>
<td>Natural incubation</td>
<td>Commercial day-old chicks</td>
<td>Commercial day-old chicks</td>
</tr>
<tr>
<td>Feed source</td>
<td>Scavenging; almost no supplementation</td>
<td>Scavenging; occasional supplementation</td>
<td>Scavenging; regular supplementation</td>
<td>Commercial balanced ration</td>
</tr>
<tr>
<td>Poultry housing</td>
<td>Seldom; usually made from local materials or kept in the house</td>
<td>Sometimes; usually made from local materials</td>
<td>Yes; conventional materials; houses of variable quality</td>
<td>Yes; conventional materials; good-quality houses</td>
</tr>
<tr>
<td>Access to veterinary services and veterinary pharmaceuticals</td>
<td>Seldom</td>
<td>Sometimes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mortality</td>
<td>Very High, &gt; 70%</td>
<td>Very High &gt; 70%</td>
<td>High &gt;50%</td>
<td>Medium &gt;20%</td>
</tr>
<tr>
<td>Access to reliable electricity supply</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Existence of cold chain</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Access to urban markets</td>
<td>No</td>
<td>No, or indirect</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Products</td>
<td>Live birds, meat</td>
<td>Live birds, meat</td>
<td>Live birds, meat, eggs</td>
<td>Live birds, meat, eggs</td>
</tr>
<tr>
<td>Time devoted each day to poultry</td>
<td>&lt; 30 minutes</td>
<td>30 minutes</td>
<td>1 hour</td>
<td>&gt; 1 hour</td>
</tr>
</tbody>
</table>

Food preference is highlighted in the concept of food sovereignty, which is broadly defined as the right of nations and peoples to control their own food systems, including their own markets, production modes, food cultures and environments. The food sovereignty movement highlights two very practical issues: 1. local production for local consumption; and 2. the vital contribution of indigenous plant varieties and animal breeds to human wellbeing. The preservation of indigenous seeds and breeds is not only important from the biodiversity perspective, but also because they are the product of an evolutionary process that has yielded biological entities that
are uniquely adapted to their environments. This is illustrated by the robustness and appropriateness of indigenous chicken breeds under resource-limiting conditions which continue to exist with minimal inputs while ‘improved birds’ that have been distributed to villages have rarely survived, let alone made a lasting contribution to the village chicken gene pool.

Table 2. Potential contribution by village poultry to the MDGs (Alders and Pym 2009)

<table>
<thead>
<tr>
<th>MDGs</th>
<th>Village poultry contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Eradicate extreme poverty and hunger</td>
<td>Improved village poultry generates income and improves household food security (Alders 2004); they are frequently the only livestock owned by the poorest in many parts of the world (Dolberg 2003).</td>
</tr>
<tr>
<td>2: Achieve universal primary education</td>
<td>Village poultry are frequently sold to pay school fees for the children of poor families (Alders and Spradbrow 2001)</td>
</tr>
<tr>
<td>3: Promote gender equality and empower women</td>
<td>Improved village poultry production has empowered poor women (Bagno 2001; Dolberg 2003).</td>
</tr>
<tr>
<td>4: Reduce child mortality</td>
<td>Village poultry and their products provide high quality nutrients and income for poor families; education for women on balanced diets and disease control for poultry can be related to family health and wellbeing (Alders et al. 2007a)</td>
</tr>
<tr>
<td>5: Improve maternal health</td>
<td>As for number 4 above.</td>
</tr>
<tr>
<td>6: Combat HIV/ AIDS, malaria and other diseases</td>
<td>Village poultry provide high quality nutrients for the ill, can be sold to purchase medicines and require little labour to raise (Alders et al. 2007b)</td>
</tr>
<tr>
<td>7: Ensure environmental sustainability</td>
<td>Village poultry contribute to pest control, provide small quantities of manure for vegetables and crop production and consume local feedstuffs that are frequently unsuitable for human consumption (Alders and Spradbrow 2001). Improved village chicken production also reduces the need to hunt bush meat (Alders and Pym 2009)</td>
</tr>
<tr>
<td>8: Development a Global Partnership for Development</td>
<td>Global partnerships have been developed that link those working with village poultry (the International Network for Family Poultry Development, the Asian Pacific Federation Working Group on Small-scale Family Poultry Farming, the Danish Smallholder Poultry Network and the IRPC), with other development and conservation organisations (Alders 2004)</td>
</tr>
</tbody>
</table>

Food safety

Food safety is an integral part of food security. The highly pathogenic avian influenza (HPAI) subtype H5N1 pandemic is an example of a food safety issue of global significance. In the wake of the pandemic, millions of poultry have been killed or slaughtered and the livelihoods of many households, especially women, severely impacted. Widespread culling of family poultry has impacted on vulnerable households, contributing to increased stunting in children under five in Egypt and decreased enrolment of girls in school in Turkey post HPAI H5N1 control activities. Other zoonotic diseases can be associated with poultry and the detection and management of these can reduce mortality and morbidity associated with salmonellosis, campylobacteriosis, cryptosporidiosis, psittacosis and other common causes of illness.
The public health community is increasingly worried about emerging infectious diseases, especially those of animal origin (both domestic and wild animals). The HPAI H5N1 pandemic has also demonstrated the readiness of vulnerable households to consume carcasses of poultry that have died of infectious disease because of food insecurity, a practice which pre-dates the pandemic. The harvesting of wildlife is also increasing as demand for bushmeat or ‘specialty’ wildlife products increases in urban areas in Africa and Asia. Communities living near wildlife areas continue hunting and gathering lifestyles as part of their basic livelihood strategies.

**Attaining sustainable safe and secure family poultry production**

Attaining sustainable food security and safety remains difficult while vast numbers of poultry die annually from preventable diseases, such as ND, and family poultry producers remain disengaged from national animal health services. Despite the millions of dollars invested in the control of HPAI H5N1, there would still appear to be some way to go with developing cost-efficient and robust poultry disease surveillance, prevention and control systems.

Implementing cost-efficient biosecurity practices remains difficult for small-scale intensive poultry producers with low profit margins, especially with huge fluctuations in feed prices. Lack of access to information and education continues to result in households and producers who are unfamiliar with the germ theory of disease and the rationale behind good nutrition and poultry husbandry. Recommendations or directives that caution households against the raising of family poultry make little sense to communities who have long experienced the positive contribution of poultry to family wellbeing. The result is a lack of compliance with biosecurity and other recommendations. Improving the understanding of animal scientists of the living conditions and resource-limitations facing family poultry producers and developing sanitary measures in a participatory manner would help to address this problem. The benefits of cooperation yielded encouraging results in Indonesia. The Village-based Biosecurity Project in South and West Sulawesi demonstrated that it is possible to develop biosecurity approaches for family poultry production that are feasible under village conditions. Another project focusing on cost-effective biosecurity for non-industry commercial poultry operations in Indonesia has made excellent progress by involving all key stakeholders in poultry health activities.

Inadequate surveillance and under-reporting of poultry diseases remains a chronic problem in many countries, both ‘developed’ and ‘developing.’ An evaluation of the animal health information system in Nigeria in the 1980s, which used rinderpest and ND as their target diseases, found that the system was characterised by late, inaccurate and gross under-reporting; less than 25% of ND outbreaks were reported to national authorities during the study period. For example, surveillance for ND in Africa has not improved despite responses, including strengthening diagnostic infrastructure, to outbreaks of HPAI subtype H5N1 in a number of African countries.

The true impact of poultry disease on communities and therefore its contribution to food insecurity is difficult to estimate because of this lack of data. For example, basic estimates of the direct economic impact of ND in Tanzania range from around US$22 million to over US$34 million annually. Even the response to the HPAI H5N1 pandemic would not appear to have significantly strengthened poultry disease surveillance as suggested by data submitted to the World Animal Health Organisation’s (OIE’s) World Animal Health Information Database (WAHID). While the data submitted to the OIE is not a reliable way of comparing surveillance activities between countries, it does serve as an indicator of the importance given by animal health surveillance systems to poultry diseases. Sensitive disease surveillance systems that provide the earliest warnings possible are those which are capable of detecting diseases which have clinical signs compatible with priority diseases.
Involving family poultry producers and communities in disease surveillance, prevention and control protocols

Cost-efficient disease surveillance activities are enhanced by the combination of classical and participatory epidemiology methodologies. The knowledge and perspectives of producers and communities obtained through participatory epidemiology activities enables the targeting of more costly classical epidemiological activities, establishes or strengthens linkages between stakeholders and provides valuable insights into local perspectives relating to disease prevention and control to help tailor future interventions. Effective disease outbreak responses occur where prior agreements have been made between producers or their representatives and relevant government agencies. To date such agreements have been made with commercial poultry producers with little attention given to family poultry producers. Control measures that do not unduly threaten food security or sovereignty are more likely to succeed. Taking a 'healthy communities approach' and employing gender-sensitive methodologies will increase participation and compliance of both men and women in disease control activities.

The development and application of thermotolerant ND vaccines has greatly reduced the impact of this disease in family poultry flocks and are also being administered to commercial poultry flocks in some tropical countries. The control of ND has contributed to improved links between producers and animal health services. Sustainable ND control provides a solid foundation on which to build cost-efficient surveillance and diagnostic services in collaboration with producers. Once family poultry flocks stabilise, producers become more interested in the control of other diseases and improved husbandry practices such as supplementary feeding.

ND epidemiology

ND is an endemic and devastating disease in African countries, and is a differential diagnosis for highly pathogenic avian influenza (HPAI). A study (Gardner and Alders 2013) which analysed the reporting data from African Union member countries of ND to OIE’s World Animal Health Information Database (WAHID) within the context of avian influenza H5N1 from January 2000- December 2011 found that of the 54 countries included, 40.7% had reported outbreak information to the OIE consistently over the study period. Three countries demonstrated a significant difference in mean number of outbreaks reported from 2000-2005 (prior to confirmed outbreaks of HPAI subtype H5N1 on the African continent) compared to 2006-2011. The study concludes that:

- surveillance for ND in Africa had not improved despite response to outbreaks of HPAI subtype H5N1, which included strengthening diagnostic infrastructure
- an analysis and evaluation of ND surveillance in Africa would aid in determining how to improve the control of an economically important poultry disease in addition to facilitating the rapid detection of HPAI, and
- improving ND surveillance would benefit the farmers and families who rely on poultry for nutrition and livelihood. It would also benefit the global vigil against emerging infectious diseases.

AU/KYEEMA Foundation ND control project description

This project is a joint endeavour involving the KYEEMA Foundation (KYEEMA), the African Union Pan African Veterinary Vaccine Centre (AU-PANVAC) and InterAfrican Bureau of Animal Resources (AU-IBAR). KYEEMA is a Brisbane based non-government organisation (NGO) working towards building a sustainable future for all. Personnel from KYEEMA and its subsidiary entity the International Rural Poultry Centre (IRPC) have been working in Southern Africa over the past 20 years in support of capacity building, community development and
poverty alleviation through developing and implementing a sustainable model for ND control and, more recently, highly pathogenic avian influenza (HPAI) preparedness. The IRPC/KYEEMA aims to contribute towards achieving the Millennium Development Goals (MDGs) by increased gender equality, food security and poverty alleviation through ND control and the improvement of husbandry practices and the prevention and control of disease in village chickens.

AU-PANVAC was launched in March 2004 as a technical centre of the African Union within the Department of Rural Economy and Agriculture (DREA). The Centre is located in Debre Zeit, Ethiopia, and was assigned the following mandates:

- provide international independent quality control of veterinary vaccines in Africa
- facilitate the standardisation of veterinary vaccines production and harmonisation of their quality control techniques
- promote the transfer of appropriate vaccine production technologies in Africa
- provide training and technical support services to veterinary vaccines and quality control laboratories and
- produce and distribute essential biological reagents for animal disease diagnosis and surveillance.

AU-IBAR, located in Nairobi, Kenya was established in 1951 as the Intercontinental Bureau for Epizootic Diseases (IBED). In 1970, it was transformed into the African Union Intercontinental Bureau for Animal Resources and is now a specialised technical office of the DREA of the African Union Commission (AUC). AU-IBAR’s mandate is to support and coordinate the utilisation of livestock, fisheries and wildlife as resources for both human wellbeing and economic development in the Member States of the AU.

This project is Phase 3 of ND control activities supported by the Australian Government in Southern Africa. Phases 1 and 2 followed on from the AusAID Southern Africa Newcastle Disease Control Project (SANDCP; 2002 to 2005) which built on the sustainable ND control model developed with Australian Centre for International Agricultural Research (ACIAR) support in Mozambique.

The project design was prepared in collaboration with the AU-PANVAC and AU-IBAR, in consultation with the Ministry of Agriculture, Irrigation and Water Development in Malawi (MAIWD), the Ministry of Agriculture in Mozambique, the Ministry of Livestock and Fisheries Development in Tanzania, and the Ministry of Agriculture and Livestock in Zambia. This initial phase is designed to develop a firm foundation with AU technical counterpart institutions while developing an expanded long-term ND control project that will include inception and training activities which will form the foundation of the larger, multi-year project.

Specific short-term objectives of this current small project are to lay the foundation for a larger ND control project by:

- establishing firm and functional linkages with AU counterpart institutions including a project office at AU-PANVAC
- development and submission to AusAID of an expanded, multi-year ND control project proposal
- development of AU accredited curricula for laboratory and field ND control master trainers
• selection of initial ND control master trainer candidates who would work alongside technical experts during the assessment of potential country partners for the larger project and
• preparation of key ND control manuals through the updating of existing ACIAR ND control field, training and laboratory manuals and translation into French and Portuguese as appropriate.

Specific short-term outputs of the current project include:
• signed MOU between AU-PANVAC, AU-IBAR, the Australian Animal Health Laboratory (AAHL) and KYEEMA and signed LoAs with relevant AU Regional Economic Communities (AU-RECs)
• AU-accredited ND control assessment tools and master trainer curricula drafted for laboratory and field level ND control activities and training of the first cohort of master trainers underway
• a multi-year ND control project prepared by AU-PANVAC, AU-IBAR and KYEEMA submitted to AusAID and
• comprehensive ND control manuals in major AU languages available for use by the larger project.

This current small project is working with partners to develop an expanded, multi-year ND control project which will strengthen the capacity of countries to control ND by:
• establishing and strengthening the capacity of African Union Member States to produce quality assured ND vaccine (using the I-2 ND strain)
• strengthening African Union Member States ND laboratory diagnosis and cost-effective surveillance capacity and
• assisting the African Union Member States in designing and implementing a vaccination program for the sustainable control of ND among rural chickens.

Specific long-term outputs of the multi-year project would include:
a. Participating African Union Member States’ capacity to produce quality assured ND vaccine (using I-2 strain) established and strengthened through:
• The provision of essential equipment and vaccine seed for the production of poultry vaccines
• Training of laboratory staff in ND vaccine production and quality control
• Identification of reliable sources for procurement of embryonated eggs and
• Quality control of ND vaccines by AU-PANVAC.
• Provision of technical support and backstopping by AU-PANVAC on NDV I-2 production.
b. Participating African Union Member States’ ND laboratory diagnostic capacity strengthened through:
• training in laboratory diagnosis of ND
• provision of diagnostic reagents
• improved linkages with disease surveillance activities and
• characterisation of local ND strains.
c. Participating African Union Member States will have designed and implemented a vaccination program for the control of ND in rural chickens through:
• training in ND vaccination
• procurement or local production of thermotolerant I-2 ND vaccine
• implementation of ND vaccination campaigns in pilot villages and
• adoption of cost-effective disease surveillance and reporting.

The key long-term outcomes of the larger project will include:
• coordination of ND control activities (prevention, surveillance and outbreak response) strengthened within and between participating countries
• strengthened capacity of AU-PANVAC to provide vaccine production and quality assurance support to member countries
• improved food security in participating villages and templates for expansion of activities within participating countries
• improved linkages between Ministries of Agriculture in participating countries and Australian ND control experts.

Conclusions
Family poultry has evolved along with human civilisation and remain an integral component of many mixed farming systems. Delivering cost-efficient, effective and sustainable health and production programs for family poultry and their owners will make a significant contribution to global food and nutrition security in AU-member states and globally.

Acknowledgements
Thanks also go the African Union Pan African Vaccine Centre, the Australian Centre for International Agricultural Research (ACIAR), the Australian Department of Foreign Affairs, the Food and Agriculture Organization of the United Nations (FAO), the International Rural Poultry Centre of the KYEEMA Foundation and the University of Sydney for their support of family poultry research and development. Our gratitude is extended to the veterinarians, poultry specialists, extensionists, traders and farmers in many parts of the world who have given freely of their time and expertise over the years.

Bibliography


OTHER NEWCASTLE DISEASE CONTROL RESEARCH AND DEVELOPMENT INITIATIVES

Innovative techniques for the delivery of I-2 vaccine to chickens

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Introduction

Newcastle disease (ND) remains one of the most devastating poultry diseases worldwide. It causes great economic losses through massive death of chickens in susceptible flocks. It is caused by Newcastle disease virus (NDV) which belongs to the genus Avulavirus under the family Paramyxoviridae (Mayo 2002).

The only feasible method for controlling ND is vaccination. Vaccines are the most important intervention for preventing associated morbidities and mortalities from ND. For commercial chickens vaccines have been used successfully and eliminated ND from vaccinated flocks. However in village chickens vaccines have not been used successfully in the control of ND for the past decades. This is because conventional vaccines which have been previously used were not suitable for village chickens in tropical developing countries due to their heat lability (thermolability) and inappropriate vaccine delivery techniques. To overcome these problems research was initiated by the Australian Centre for International Agricultural Research (ACIAR) to develop appropriate ND vaccines for use in developing countries. This research resulted in the development of V4 (Spradbrow 1993-94) and I-2 (Bensink and Spradbrow 1999).

For the past 17 years I have been intensively carrying out research on NDV particularly strain I-2 in Tanzania and overseas with the support of the Government of Tanzania through the ministries responsible for Agriculture and Livestock Development, ACIAR, World Bank through the Tanzania Agricultural Research Project Phase II (TARP II), the University of Queensland, Sokoine University of Agriculture (SUA) and Central Veterinary Laboratory (CVL) Temeke, Dar es Salaam. The research involved the study of biology of the NDV, vaccine development (safety, efficacy, potency and innocuity), vaccine storage, delivery and vaccination techniques, and molecular biology of the virus. Notable achievements of this research include the sequencing of the full length genome of I-2, which revealed new insights in the length and nucleotide sequences of the Fusion, HN and L genes. The research also resulted into the development of new processes or products such as assays for rapid determination of the potency of I-2 vaccine, green coloured vaccine and coating of I-2 vaccine on to oiled rice for oral vaccination of feral and semi-domesticated birds.

I-2 vaccine is used in multi-age flocks, where all ages of chickens receive a single dose (eye drop) every 3 months. The vaccine can be stored at room temperature (22-25 Cº) for up to 30 days and in villages where there is no refrigerator, it can be stored for long periods in cool places such as near the base of a clay water pot. If cool boxes and ice packs or even frozen water are not available for transporting I-2 vaccine at village level, the vaccine container may be wrapped in a damp cloth and carried in a covered open-weave basket. This allows evaporative cooling, which helps to keep the vaccine cool.
The I-2 vaccine is used in more than 28 developing countries in Africa, Asia and Latin America. Through the use of this vaccine and its associated storage and delivery techniques, many countries have reported reduction of mortality due to ND and increased populations of village chickens in recent years.

**Innovative techniques for the delivery of I-2 vaccine to chickens**

Delivery of ND vaccine to village chickens in developing countries with a tropical climate has been a major challenge over the years. Research was undertaken to try to find ways of improving delivery and the administration of ND vaccine to chickens.

**Food-based I-2 vaccine**

Village chickens are kept in multi-age flocks, scavenge for food and frequently roost in trees overnight so it is not easy to catch them in order administer the I-2 vaccine by conventional methods such as eye drop, drinking water or injections. Innovative techniques are therefore required to deliver this vaccine to these chickens.

Cooked white rice has been an effective carrier for V4 and I-2 ND vaccines, although it is subject to bacterial spoilage (Jayawardane et al. 1990; Samuel et al. 1993; Biswas et al. 1996; Tu et al. 1998). Raw white rice has not been a good carrier for oral vaccination probably because of its antiviral activity (Tantaswasdi et al. 1992; Spradbrow 1993/94). This is unfortunate because white rice is readily available in many developing countries and could be an ideal carrier for oral vaccines as it is stable, cheap and attractive to chickens. Methods are required to overcome the antiviral activity in raw white rice. Several experiments were conducted to determine the effects of various treatments of raw white rice on the survival of strain I-2 of NDV. Mixing the rice with vegetable oil prior to coating with vaccine virus has been one of the best methods (Wambura et al. 2007). Vegetable oil protects the NDV from inactivants present in raw rice grains (Wambura et al. 2007) and the oiled rice can stay longer at room temperature without being spoiled than cooked rice.

In this study the vaccination of chickens against ND using I-2 vaccine coated on oiled rice resulted in seroconversion. Previous studies showed that vaccination by the oral route (particularly via feed) resulted into protective antibody responses after multiple vaccinations (Spradbrow and Samuel 1991; Johnston et al. 1992; Wambura et al. 2000). In contrast the results from the present study showed that chickens had developed a protective antibody response seven days after vaccination (Wambura 2009). The reason for this difference is not known but could be due to the effect of oil acting as an adjuvant. Other studies have shown similar effects of oil when using live ND vaccine via eye drop and inactivated vaccines by injection (Rehmani and Spradbrow 1995).

This food-based vaccine which utilises materials that are readily available in local areas provides another vaccination regime apart from eye drop and drinking water. Moreover, this vaccination regime will make vaccination easier as the vaccinators and farmers can prepare the rice grain in the evening and provide it to the chickens before they go out for scavenging early in the next morning.

The I-2 virus coated on the oiled rice has been shown to be safe, immunogenic and provoked production of protective antibody response following vaccination of chickens.

Oiled rice coated with I-2 vaccine may therefore have potential application in vaccination of feral chickens as well as wild birds which are now domesticated and are difficult to handle such as Guinea fowls, ostriches and quails.
Coloured I-2 vaccine
I-2 vaccine is becoming popular due to its thermostolerance and ease of administration by eye drop while giving good protection against virulent virus (Tu et al. 1998; Wambura et al. 2000). However some vaccinators have difficulty in determining if the entire first drop enters the eye when using the eye drop method of vaccination. This is because the vaccine is colourless, the same as lachrymal secretions. The need for having a virus friendly dye which will not harm or inactivate the virus is therefore warranted. This will enable a vaccinator to determine whether or not the vaccine drop has entered the eye, and if not a second drop should be applied.

The most common cause of vaccine failure in poultry is poor vaccine administration. The colour is a visual marker for the vaccine during administration (Cargill 1999) and hence may help to assess efficiency of vaccine administration especially by eye drop.

The study was conducted to determine the suitable colour to be used for eye drop vaccination.

The results of the present study have shown that the green coloured vaccine is safe in chicken embryos as well as in vaccinated chickens. This vaccine is also immunogenic and resulted in antibody of titres of $\geq 2^4$ which is considered to be protective against field challenge of NDV in chickens.

Use of nanotechnology in delivery of I-2 vaccine
Nanotechnology is a novel discovery - a field of applied science and technology which deals with the control of matter on the molecular level in scales smaller than 1 micrometre, normally 1 to 100 nanometers (nm), and the fabrication of devices within that size range. Most conventional vaccine delivery techniques are non-targeted and invasive. One of the attractive and innovative nanotechnologies is the non-invasive systemic or local vaccine delivery to the host by means of the nanoparticles. Nanotechnology has the potential to revolutionise the way vaccines are developed and used, and the knowledge of vaccinology as a whole. The nanotechniques may be used to improve I-2 vaccine delivery to chickens and hence enhance its efficay.

Use of nano-organogels
Organogels are semi-solid systems, in which an organic liquid phase is immobilised by a three-dimensional network composed of self-assembled, intertwined gelator fibers. In the present study nano-organogels were prepared and contained $10^{9.5}\text{EID}_{50}/0.1\text{mL}$ of I-2 virus. After 12 weeks the infectivity titre was $10^{7.5}\text{EID}_{50}/0.1\text{mL}$, which is above the recommended $10^7\text{EID}_{50}/\text{mL}$ for oral vaccination. The vaccine was stable at room temperature, safe and produced a protective antibody response in vaccinated chickens. Moreover rice coated with trehalose nano-organogel vaccine was used for oral administration and hence suitable for mass vaccination.

Most conventional ND vaccines are heat sensitive; and the temperature range within which these vaccines remain stable is very narrow. Heat stable vaccines may be the best approach to control ND in village chickens. Therefore sealing the vaccine inside a sugar glass can effectively broaden the temperature range over which vaccines can survive without inactivation. In addition, the vaccine can be prepared and coated on feed like rice with nano-organogels.

Because nano-organogel vaccines contain no preservatives and are stable at room temperature for prolonged periods, they can be distributed without the need of refrigeration through regular distribution outlets. Application of this technology may greatly increase vaccination coverage particularly in remote rural area where basic infrastructure is lacking. Another advantage of these
technologies is that the production of the nanogels is simple and uses natural biodegradable materials.

Sugar-glass technology allows vaccines to be made which can be stored and transported routinely at a tropical room temperature. The ultimate goal of this technology is to develop a system where thermostolerant vaccines can be delivered to remote rural areas in the same way as drugs without a cold chain while maintaining their potency and efficacy. In conclusion, the present study showed that it is feasible to formulate nano-organogels incorporating strain I-2 vaccine virus coated on rice for oral vaccination of village chickens.

**Formulation of I-2 vaccine flakes**

Formulation of I-2 vaccine flakes showed substantial improvement in storage stability over wet (liquid) vaccine. The flakes were developed by sugar-glass-technology using an amorphous trehalose glassy matrix as a stabiliser. The vaccine flakes are green coloured for easy visual identification and delivery to chickens, particularly by eye drop.

The development of thermostabilised dry vaccines and delivery technologies may help to overcome the cold storage and current distribution systems and delivery methods. Dry vaccine formulations are potentially superior to liquid vaccines in their sterility and stability thus eliminating the need for the cold chain. The findings from the present study have shown that the trehalose vaccine flakes have several distinct practical advantages over liquid formulations. They were stable at room temperature, required no preservatives, easy to carry and therefore can be transported free of the limiting cold chain systems.

The value of the present study is that the trehalose vaccine flakes may be delivered and administered to chickens through eye drop, nasal drop, drinking water or orally (via feed or alone). Chickens vaccinated with vaccine flakes developed a protective antibody response and survived challenge with virulent NDV. The present results corroborate the findings from the previous studies which showed that vaccination of chickens with NDV strain I-2 results in protection against subsequent ND challenge.

The trehalose vaccine flakes could be a useful formulation in order to produce new and affordable ways to store and deliver ND vaccines to village chicken flocks in rural areas particularly in developing countries. If this technology is optimised and adopted it could greatly expand the availability and the coverage of vaccination of chickens against ND in rural areas that lack basic infrastructure. This study demonstrated that it is feasible to produce dry flake formulation of an avirulent thermostolerant live vaccine for single and mass vaccination of village poultry.

**Formulation of novel nano-encapsulated I-2 vaccine tablets**

Formulation of nano-encapsulated vaccine tablet is a novel technique for the delivery of ND vaccine to village chickens. Vaccine tablets were prepared using gelatin, trehalose and casein as thermostabilisers and binders, respectively and each vaccine tablet contained a nominal oral dose of NDV strain I-2 for a single chicken. These ND vaccine tablets maintained a titre of 6.7 EID$_{50}$/0.1 mL for 90 days at ambient room temperature. When the vaccine tablets were given to village chickens a single oral administration of the vaccine produced protective antibody response against challenge with virulent NDV.

This study has demonstrated that this natural biodegradable nano-encapsulated antigen delivery technique has the potential for prolonged protection. If the vaccine tablet formulation technique is optimised, it will allow the delivery of the ND vaccine to rural areas in tropical countries.
without depending on cold chains. The biotechnology of producing natural dry nano-encapsulated tablet vaccines with enhanced thermostability applied in the present study may be used for other vaccines intended for semi-feral and scavenging village chickens.

**Conclusion**

There are still new frontiers of science such as:

- Recombinant techniques
- Transgenic plants
- Nanotechnology
- Vaccination of semi-domesticated birds.

These may be used to improve delivery of I-2 vaccine to chickens and hence enhance its efficacy.

**Diseases emerging after ND is effectively controlled:**

- Fowlpox - strain TPV-1 FP live vaccine free from REV has been developed, inoculated through eye drop.
- Infectious coryza- serovar B of *Avibacterium paragallinarum* live vaccine inoculated through eye drop.

**References**


The Role of AU-IBAR in the management of transboundary animal diseases and zoonoses in Africa
Zelalem Tadesse,
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AU-IBAR

Historical background of AU-IBAR
The African Union Interafrican Bureau for Animal Resources (AU-IBAR) was established in 1951. Since its establishment, the institution has gone through remarkable institutional changes in terms of mandate, scope and size.

It was initially created as Interafrican Bureau of Epizootic Diseases (IBED) with an objective of controlling epizootics, with a main focus to eradicate rinderpest. In 1956, it broadened its scope to include addressing all animal health challenges on the continent, and consequently renamed as Interafrican Bureau for Animal Health (IBAH). After a period of one decade, the institution became the technical arm of the then the Organization of African Union (OAU), which is currently known by the name of African Union (AU). Following its integration into the institutional structure of the AU, the office got its current name as Interafrican Bureau for Animal Resources (IBAR) in 1970. With this change, the mandate of IBAR has also evolved significantly to include all aspects of animal resources development on the Continent including livestock, fisheries and wildlife.

Vision, mandate, strategic programs of AU-IBAR
By building on past successes as well as cognisant of the many and complex challenges facing the development of the animal resources sector, AU-IBAR developed a Strategic Plan (SP) in 2009 that covered a period of five years from 2010 – 2014 with the view to unlock the potential of the sector and contribute to food security and poverty reduction on the Continent.

The SP articulated the vision, mission, mandate and the various strategic programs as follows:

**Vision**
An Africa in which animal resources contribute significantly to the reduction of poverty and hunger.

**Mission**
To provide leadership in the development of animal resources for Africa through supporting and empowering AU Member States and Regional Economic Communities (RECs).

**Mandate**
To support and coordinate the utilisation of animals (livestock, fisheries and wildlife) as a resource for human wellbeing in the Member States, and to contribute to economic development, particularly in rural areas.

**Strategic Programs**
The SP (2010 – 2014) has six inter-connected and complementary strategic areas, referred to as ‘programs’ that form the core of the SP.

**Program 1:** Reducing the impact of transboundary animal diseases and zoonoses on livelihoods and public health in Africa (TADs and Zoonosis)
Program 2: Enhancing Africa’s capacity to conserve and sustainably use its animal resources and their resource base (Natural Resources Management)

Program 3: Improving investment opportunities in, and competitiveness of animal resources in Africa (Investment and Competitiveness)

Program 4: Promoting development of standards and regulations and facilitation of compliance (Standards and Regulations)

Program 5: Facilitating development of policies and institutional capacities for improved utilisation of animal resources in Africa (Policies and Capacity Building)

Program 6: Improving knowledge management in animal resources to facilitate informed and timely decision-making (Knowledge Management)

Initiatives of AU-IBAR in the management of TADs and zoonoses
AU-IBAR addresses TADs and zoonoses through development and implementation of specific projects, which support Member States to enhance their capacities in the management of TADs and zoonoses. In addressing TADs and zoonoses, AU-IBAR recognises the importance of regional approach and coordination in the management of TADs and zoonoses. To this effect, it works closely in partnership and alliance with other technical organisations. Some of these initiatives include, inter alia, the following:

Enhancing Surveillance and Animal Health Information System
Cognisant of the fact that adequate and accurate data are key for disease prevention and control programming, AU-IBAR supports Member States to strengthen their capacity for enhanced animal disease surveillance and animal health information system (AHIS). In this regard, it supports MS in the following specific areas:

- building the capacity of Member States by providing trainings, ICT equipment, vehicles, etc.
- developing and cascading the application of web-based AHIS platform known as Animal Resources Information System (ARIS)
- monthly collection, collation, analysis and dissemination of sanitary data and information
- publication of annual animal health situation reports on the continent.

Using the animal health data submitted by Member States on a monthly basis, analysis is done at AU-IBAR level to understand the trend and continental perspective of each reported disease. Some of the outputs of such analysis include understanding the spatial and temporal distribution as well as the relative importance of diseases on the continent (see some examples below).
Improving policy environment to enhance animal health delivery system

It was reported that lack of favorable policy environment is one of the critical gaps identified by the OIE PVS evaluations among many Member States. Prompted by such findings, AU-IBAR is supporting Member States to improve their institutional environment of national veterinary services (VS) to ensure delivery of effective and efficient animal health services.

Through one of its current projects known as Veterinary Governance (VetGov) project, AU-IBAR undertakes advocacy for institutional change and increased investment. It also support Member States to update and improve legal instruments (livestock/animal health policy and strategies), which are the basis for further investment and subsequent improvement of other critical competencies of the VS.
Improving standard procedures in animal health delivery system
One of the approaches AU-IBAR is pursuing to address TADs and zoonoses is regional standardisation of core functions of VS such as surveillance, laboratory diagnosis and disease control measures with a view to harmonise systems and maximise impact.

In this regard, AU-IBAR in partnership with IGAD is implementing a project called Standard Methods and Procedures in Animal Health (SMP-AH) in order to achieve the following:

- Support development of standard procedures for surveillance and control of trade related diseases - harmonisation of standard procedures at regional level
- Facilitate intra-regional trade by supporting development and enforcement of quarantine standards - harmonisation of quarantine practices
- Building capacity of Member States to improve compliance with regional and international standards and procedures in the functions of VS

Enhancing compliance with international standards
In a bid to improve the trade performance as well as disease control strategies of AU Member States, AU-IBAR supports Member States of AU in the following areas through a project known as PAN-SPSØ (Participation of African Nations in Sanitary and Phytosanitary Standard setting Organisations). The main support areas of PAN-SPSØ are:

- Enhance the participation of AU Member States in standard setting organisations and enhance their compliance with international animal health standards
- Support capacity building of Member States for improving compliance with SPS measures,
- Coordinate common position of AU Member States to defend their interest when standards are set at the international stage - OIE, Codex.

Coordinating Prevention and Control of Priority Diseases
One of the major tasks of AU-IBAR is to coordinate the prevention and control of priority animal diseases on the Continent. In this regard, it undertakes the following in coordination and partnership with other continental and global actors:

- Support development of disease control strategies and programs against priority TADs
- Support Member States to develop preparedness and contingency plans against priority diseases
- Enhance disease early detection through building capacity of diagnostic laboratories
- Support Member States to undertake control measures against priority diseases.

Strengthening regional coordination mechanisms
In order to sustainably address the impacts of TADs and zoonoses, it’s critical to coordinate disease control actions at regional level. It emanates partly from the intrinsic nature of infectious diseases, which don’t respect political boundaries requiring collective efforts for success and sustainability. It’s actually one of the lessons mentioned for successful eradication of rinderpest.

Cognisant of this fact and prompted by the increasing need of regional approach for effective management of TADs and zoonoses, AU-IBAR has been partnering with FAO and OIE in an effort to establish Integrated Regional Coordination Mechanism (IRCM) in eight RECs that are recognised by the AU. The two main objectives of the IRCM are:

- Strengthen the capacity of RECs for effective coordination and harmonisation of strategies and interventions against priority diseases, and
- Promote the OH approach to address zoonoses.
Newcastle disease control in backyard poultry in Ethiopia
Gedlu Mekonnen
FAO
Ethiopia

Background
Smallholder farming systems in the highlands of Ethiopia are dominated by cereal cropping but smallholder farmers also keep small numbers of livestock, especially sheep, goats and poultry. Livestock are herded in communal pastures or tethered near the homestead where they utilise available forage and chickens scavenge in the backyard. The chicken population of Ethiopia is estimated to be 50,377,142 (Ethiopia Central Statistics Agency 2013). The majority (99%) of the chickens are kept under the traditional system with few or no inputs for housing, feeding or health care. According to Ethiopia Central Statistics Agency, 96.9% of the chicken population is indigenous, 0.54% hybrid and 2.56% exotic breeds.

Backyard poultry represent a significant part of the national economy in general by contributing 98.5% and 99.2% of the national egg and chicken meat production, respectively (Tadelle 1996; Aberra 2000). Ethiopian indigenous chickens have a variety of morphological appearances. They vary in colour, comb type, body conformation and weight, and may or may not possess shank feathers. Dominant chicken types are local ecotypes that show a large variation in body confirmation, colour, comb type and productivity. The average number of chickens per household in most Ethiopian rural communities is 7 to 10 mature chickens: 2 to 4 adult hens, a cock and a number of growers of various ages. In Ethiopia, the backyard chicken lays between 36 and 40 eggs per year with a hatching rate of 80.9% (Tadelle et al 2000; FAO 2004).

The major challenges in village chicken production include diseases, feed and predators. The number one limiting factor in backyard poultry production is Newcastle disease (ND) with a high mortality rate that could reach as high as 80 to 90% within the first few weeks after hatching. Diseases such as salmonellosis, coccidiosis and fowlpox and internal and external parasites also have a great impact on the poultry population. The second factor limiting village chicken production is feed, both in terms of quantity and quality. Feed shortage is particularly serious during the short rainy and dry seasons. Predators are a major constraint to backyard poultry production and cause very high losses young chicks. The overall productivity of backyard poultry is debatable; some say it is not productive while others argue that it is highly productive and resilient under the current low input management system.

The proposed FAO project intervention will therefore target backyard chickens owned by poor smallholder farmers with a view to increasing the production and productivity of poultry and consequently increasing the availability of eggs. The objective of the project is to improve the nutritional status of smallholder households. The following interventions are proposed:

- Standardise the presentation of thermotolerant vaccine produced by the National Veterinary Institute, i.e. droppers, diluent and lyophilised vaccine
- Train community members, mainly women poultry owners, in vaccine handling and vaccination techniques
- Vaccination conducted by the trained women
- Pilot the provision of concentrate feed during difficult months of the year and protection from predators using locally made chicken boxes.
The decrease in mortality and increase in productivity may encourage the owners to invest more in poultry production.

The project aims to vaccinate about 4,000,000 backyard chickens with I-2 ND vaccine at least twice a year. Awareness at community level will be created through meetings, flyers and posters in local languages. The project will cover the community awareness campaigns, the training of women and the vaccine costs. To guarantee sustainability the second round of vaccination will be conducted on a full cost recovery basis. Initially the owners will pay the trained women vaccinators for the vaccine delivery service, but finally the full costs of services and the vaccine will be charged to enable the vaccinators to purchase the vaccine in consequent vaccination programs.

**Table 1.** Targeted areas and planned number of backyard chickens included in the ND vaccination program

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of districts</th>
<th>Number of chickens targeted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amhara</td>
<td>28</td>
<td>2,400,000</td>
</tr>
<tr>
<td>SNNP</td>
<td>20</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Tigray</td>
<td>8</td>
<td>600,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>56</strong></td>
<td><strong>4,000,000</strong></td>
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Donors: Central Emergency Response Fund of the UN and Government of Japan

In pilot areas ND vaccination will be complemented by a package of supplementary feeding during critical periods of the dry spells, i.e. about two to three months per year. This will improve the body condition and especially the availability of eggs during the critical time when food is in short supply. Moreover, survival rates of the young chicks will increase by the introduction of locally made brooder boxes, to protect them from predators.

The expected outcome of the pilot intervention is improved child nutrition and household income and possibly an increased interest in investing in backyard poultry production.
Newcastle disease a GALVmed perspective
Patrick Traill
GALVmed

Adoption Principles
1. Quality
2. Availability
3. Accessibility
4. Demand

1) Quality
   a) Vaccine production at public and private facilities
2) Availability
   a) Consistency of supply
   b) Scalability
3) Accessibility
   a) Free flow of vaccine through the supply chain to the end user
   b) Ensuring all key stakeholders are engaged, considered and on board
4) Demand
   a) Pull through from keepers at village level

Project Operational Principles
GALVmed doesn’t have a standard model, but operates on a series of principles. They include:
1. Real long term sustainability
2. Global access
3. Quality products
4. Local solutions

Distribution models
Supply
1) Manufacturer, Can be government manufacturer, but vaccine is paid for or importer
2) Distributor
3) Retailer

Independent vaccinators
Official Vets / Extension Officers
Private vets

Supply chain example
1) Manufacturer
2) Distributor
3) Retailer in rural areas
4) Re sellers at market
5) Vaccinators
6) Farmers
Interventions needed at different levels = different types of expertise
Importance of flexibility and availability of local, multiple skills.
Newcastle disease vaccine distribution so far

ND distribution models

1) Private veterinarians:
   a) Burkina Faso
   b) Lesotho
2) NGOs:
   a) Nepal: Heifer International
   b) India: BMPCS
   c) India: PRADAN
   d) Cameroon: Heifer International
   e) DRC: CAVTK
3) NGOs + private sector:
   a) Tanzania: CAHNET + local shops

Private veterinarians: Burkina Faso
1. Importer
2. Private vet
3. Vaccinators
4. Farmer

NGOs + private sector: Tanzania
1. CVL (Dar es Salaam)
2. Distributor (Arusha)
3. Retailer (District) x 3
4. Agroshop (Ward) x 12
5. Vaccinators
6. Farmer

**GALVmed ND Strategy**
Contribute to improved adoption which ultimately contributes to improved poultry productivity

**Activities**

1. Increase production of vaccine
   1. small pack size
   2. strengthen manufacturing capability
2. Models: Margins down the chain are very small, scale-up current pilot projects
3. Cold chain at all levels
4. Establish new pilot projects
5. Working with partners
**Some mitigation actions undertaken in Africa**

Dr. Yacouba Samaké

OIE

The presentation focused on some technical recommendations presented during the OIE regional conferences for Africa, namely Recommendation No. 2 of the 15th conference held in Maputo on February 2003, which dealt with the role of the animal disease control mentioned in the strategy of Poverty Reduction and Food Security, Recommendation No.1 of the 17th conference on the epidemiology surveillance in Africa held in Asmera in February-March 2007, and Recommendation No.1 of the 14th conference held in Arusha in January 2001.

Newcastle disease is defined according to the OIE terrestrial code glossary.

The presentation included a reminder of the importance of the disease in Africa, especially in traditional poultry, for poverty reduction and the fight against malnutrition. To underline the importance and referring to the animal health situation in 2009 (extracted from WAHID of OIE), Newcastle disease is one of the 11 diseases that affected a large number of animals, among the 10 diseases that killed most animals and for which the total sum of animals killed, destroyed and slaughtered is the highest.

Maps of the disease in Africa in 2011 and 2012 were presented. It was emphasised that the disease is one of the priority diseases included in the five-year GF-TADs/Africa action plan.

Regarding the role and responsibilities of OIE member countries, in accordance with the OIE Terrestrial Code, the following were pointed-out:

- Recommendations stipulated in the articles of the Terrestrial Code: articles 10.9.1 to 10.9.26
- Disease listed in OIE
- Endemic disease in most African countries must be mentioned in biannual and annual reports
- Exceptional epidemiological event: only Libya notified immediately.

The situation of the disease in Burkina Faso was also presented. It shows the improved vaccination strategy that led to an increase in the vaccination rate of 50% from less than 30%.

Finally, some recommendations were made:

- Forward the necessary information to OIE
- Provide data to GF-TAD/Africa to establish a baseline
- Prepare National Emergency plans and the RECs should prepare and implement the regional control strategy
- Reinforce the capacity of the laboratories
- Pursue vaccine quality control done by PANVAC/AU.
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