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Project final report

project	**Control of Newcastle disease and identification of major constraints in village chicken production systems in Myanmar**
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Contents

1 Acknowledgments

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2 Executive summary

Village chickens are a common livestock species for many rural families in Myanmar. They are raised as a source of petty cash and also provide food for the household and gifts for special occasions. According to the 2002-2003 census, the total chicken population in Myanmar was estimated to be 71.2 million. Of these chickens, approximately 84% were village chickens and the remainder were commercial layers and broilers. The project focused on improving food security, nutrition and income of villagers in Myanmar by addressing the major constraints to productivity of scavenging village chickens.

There was limited information on the factors influencing village chicken health and production in Myanmar prior to this project. A major component of the project was a series of epidemiological studies conducted to identify the major constraints to village chicken health and to evaluate strategies with the potential to improve village chicken production. Initially, a baseline survey confirmed the importance of chicken keeping to rural farmers in Myanmar, with chicken-keeping being ranked as their second most important wealth producing activity (behind crop production). The survey also indicated that mortality in young chicks and deaths from Newcastle disease were two major constraints to improving chicken production in villages. This was confirmed in a 6-month longitudinal panel study. In this study prevalence of protective titres from field exposure to Newcastle disease virus was 79%. High prevalence at village level appeared to be protective against mortality; mortality rates decrease by a factor of 0.88 for every 10% increase in prevalence of titres in the previous month. These issues were then addressed in a 12-month intervention study with Newcastle disease vaccination and improved management applied to randomly selected flocks. This work demonstrated a significant increase in the number of birds sold after a period of 6-months in the group of farmers who introduced changes to the management of young chicks, resulting in additional income from the sale of birds. The number of households consuming home-produced chicken meat also increased in this

group. Molecular characterisation of ND viruses circulating in Myanmar revealed that genotype VII was predominant.

The project aimed to advise village farmers on simple and sustainable approaches to maintaining good village chicken health and production and to increase the general awareness amongst village farmers towards the economic benefits of chicken keeping. An extension program was developed, including the production of extension materials based on the outcomes of the epidemiological studies. A series of farmers meetings were conducted to demonstrate to farmers the production benefits of introducing chick management changes and Newcastle disease vaccination and to discuss the extension messages. The extension work was expanded from the original 12 villages being involved in the field studies to a total of 47 villages in three administrative divisions of Myanmar. Nearly 4000 farmers were trained in village chicken health issues. Sustainability was a major obligation for the project and key village people were identified in each of the 47 villages to conduct further support of village chicken farmers by conducting training workshops on village chicken health, promoting I-2 ND vaccination and selling locally produced equipment to improve the management of young chicks (bamboo coops, creep feeders and starter feed). The capacity impacts of this project were remarkable. Training was provided in epidemiology, pathology, vaccine production, extension methods, and molecular assays.

This project used a stepwise approach conducting scientific investigations involving the village chicken-owning community and a participatory development of extension material and services to increase the awareness of small holder poultry owners towards village chicken health and production. Poor farmers were the direct beneficiaries of this project: by improving the survival rate of young birds, more birds could be sold at the markets and consumed in the village households.

3 Background

The UNDP Human Development Indicators show Myanmar to be ranked below many of its neighbours. For example, the percentage of underweight children under age 5 from 1995-2000 was 39% in Myanmar compared to 10% in China and 19% in Thailand. Life expectancy at birth in 1999 was 56.0 years in Myanmar compared to 70.2 and 69.9 years in China and Thailand respectively[1].

The rural population of Myanmar comprises 75% of the country's total population[2]. Village chickens are one of the most important livestock species for many rural families in Myanmar. They are raised as a source of income and also to provide food for the household. Chickens cost little in money or labour to rear and provide the family with food, petty cash and gifts for special occasions. According to the 2001-2002 census, the total chicken population in Myanmar was estimated to be 48 million. Of these chickens, approximately 40.8 million (85%) are village chickens and the remainder are commercial layers and broilers.

The average flock size of rural chickens per family in Myanmar was expected to be small. The chickens are kept under free-range conditions and are left to scavenge for themselves with little or no supplementary feed provided. Feed when provided consists of rice bran or household scraps and may be fed to the birds three times per day. Some families house their birds at night in poultry sheds or small shelters while others leave their birds to roost in trees. The birds are used for home consumption or are sold to dealers/middlemen who regularly visit villages to purchase chickens.

Newcastle disease is a viral disease of poultry with mortality rates up to 100%. It is the most important constraint to village chicken production in most developing countries[3]. In

Myanmar, Newcastle disease outbreaks occur mainly in the cooler period between October and February, with the peak occurring in December. The mortality rate ranges from 40-60%, and young birds (2-20 weeks old) are the most vulnerable. Other poultry diseases of significance in Myanmar include fowl cholera, infectious bronchitis, *Salmonella pullorum* infection, avian mycoplasma and infectious bursal disease.

Newcastle disease can be controlled by the use of appropriate vaccines. Protection of the chicken population through vaccination programs results in increased numbers of chickens, which leads to higher consumption of poultry meat and eggs or increased income from the sale of poultry products. The key beneficiaries from programs that control Newcastle disease in chickens are the village people (men, women, children) who rely on poultry products for food security and/or disposable income.

The key aims of the research project were to improve the production, quality and distribution of I-2 Newcastle disease vaccine in Myanmar, to enhance sustainable usage of Newcastle disease vaccine through improved extension methodologies, and to identify the major constraints to village chicken production. The project planned to combine and integrate research activities with training of staff in both the field and in diagnostic laboratories. The capacity of government veterinary staff to diagnose poultry diseases would be enhanced and the skills and knowledge base of staff in the vaccine production laboratory improved through participation in these training courses.

Since 1984 ACIAR has supported the development of thermostable Newcastle disease vaccines for use in developing countries[4]. The initial work focused on strain V4, which was an avirulent virus isolated from Australian chickens and responded readily to selection for enhanced heat resistance (NDV4-HR). Following the commercialisation of NDV4-HR, ACIAR sponsored the development of a new thermostable vaccine based on another avirulent Australian virus (strain I-2)[5]. This strain has properties similar to NDV4-HR but has no commercial ownership and is available to developing countries. The goal has been to encourage local production of the vaccine, which results in low production costs and promotes sustainability. In addition to research on technical aspects of the I-2 vaccine, ACIAR has supported the development of specific extension packages and activities in order for sound distribution networks to be established and to ensure the long-term sustainability of Newcastle disease control programs[6,7].

The master seed of strain I-2 Newcastle disease vaccine was introduced into Myanmar in 1998 as part of a FAO-sponsored Newcastle disease control program. Training workshops on practical laboratory skills and on extension methodologies were held to facilitate local production and distribution of the vaccine. I-2 vaccine produced in the central laboratory of the Livestock Breeding and Veterinary Department (LBVD) of the Ministry of Livestock and Fisheries was supplied to an FAO/UNHCR project based in the returnee/refugee areas of Rakhine state. A nationwide Newcastle disease control program based on the I-2 vaccine was commenced in Myanmar in October 2000. The aim was to vaccinate 20% of the rural poultry population in 2000, increasing this figure to 30% in 2002. The LBVD is responsible for the conduct of the control program and produces about 25 million doses per year. The Department subsidizes the cost of the vaccine, spending approximately 6 million kyats per year on the Newcastle disease and fowl cholera vaccination programs. The Newcastle disease vaccine was to be given four times each year (March, June, September, and December).

The vaccine for the control program is produced in two different forms (freeze-dried and liquid), but only the liquid form will be produced in the regional laboratories. This project planned to facilitate the expansion of vaccine production expertise into regional laboratories by providing appropriate training opportunities and ensuring a high quality of the vaccine production under Myanmar conditions.

A number of problems in the nationwide Newcastle disease control program and in village chicken health and production have been identified. There have been concerns regarding the efficacy of the I-2 vaccine. The lack of awareness of rural farmers about Newcastle disease and poultry diseases in general was regarded as a major constraint to the success of the program. However, the major constraints to village chicken production had never been evaluated for this country. This project aimed to address some of these issues and to assist the LBVD in removing these constraints and to achieve high vaccination coverage.

Epidemiological studies were to be conducted to identify the major constraints to village chicken production systems, to quantify the impact of Newcastle disease vaccination and to provide solutions in experimental field settings. Through extension methodologies, the project aimed to increase farmers' awareness of improved village chicken health and the benefits of vaccinating against Newcastle disease.

4 Objectives

The following list specifies all the objectives set during the entire project period. Objectives 1-5 were from the original project proposal; the additional objectives refer to the extension periods of this project.

Objective 1: To enhance the production, quality and distribution of thermostable Newcastle disease vaccine in Myanmar.

A refresher course on I-2 Newcastle disease vaccine production and quality control will be held. An expansion of sites for the production of I-2 vaccine under the current national Newcastle disease control program will be supported by supplying expertise and equipment. The use of liquid I-2 vaccine under Myanmar village conditions will be evaluated.

Objective 2: To develop appropriate extension materials to enhance sustainable usage of Newcastle disease vaccines and to improve the capacity of government staff in extension methodologies. [also an objective in Extension I]

Extension materials will be designed that are based on the results of the scientific investigations. Extension services not yet existing for animal health in Myanmar are planned to be developed.

Objective 3: To improve the capacity of government staff to diagnose the major diseases of village poultry.

Training on the diagnosis of poultry diseases will be held for field and laboratory staff. In addition, training will be provided in other fields that are essential for the diagnosis of poultry diseases.

Objective 4: To determine the major constraints on the production of village poultry in Myanmar, to specifically evaluate the impact of Newcastle disease and the effect of vaccination.

A number of households will be selected and surveyed for flock structure, productivity and disease status. Samples will be collected regularly and transported to the central diagnostic laboratories for testing. Any deaths will be investigated and diagnosis of the cause of death made wherever possible and virus isolation will be attempted. The results of this survey will identify the major constraints limiting production in village chickens and lead to the evaluation of appropriate intervention strategies.

Objective 5: To genetically characterise field isolates of Newcastle disease virus from Myanmar and to confirm the efficacy of I-2 vaccine against these isolates. [also an objective in Extension I]

Field isolates of Newcastle disease virus will be obtained from the village survey in Objective 4 and from other cases of Newcastle disease that are brought to the attention of the participating staff. These virus isolates will be characterised genetically.

Objective 6: To complete the assessment of the impact of improved chick rearing and Newcastle disease vaccination on the production and profitability of village chicken-keeping in the current field locations. (Extension I)

The most cost-effective strategy and the best cost-recovery system for sustainable Newcastle disease control and chicken management will be identified. The impact of single interventions and combinations of interventions will be compared. The impact of the intervention strategies under different seasonal conditions will be assessed.

Objective 7: To improve the capacity of local veterinarians in epidemiological techniques to investigate and control poultry and other animal health problems under local conditions. (Extension I)

The epidemiological skills of Myanmar veterinarians will be increased through a series of training courses. This training will allow Myanmar veterinarians to conduct their own investigations into animal health problems using scientific approaches and will assist in the development of surveillance methodologies.

Objective 8: To expand the extension activities commenced in 2005/2006 beyond the original study site areas and incorporating broader aspects of chicken health. (Extension II)

Extension work will focus on increasing awareness amongst village farmers on the economic benefits of chick management and Newcastle disease vaccination to village chicken production. Extension materials (pamphlets, calendars, flipcharts, posters) developed in the original project will be expanded to include materials on biosecurity and other infectious poultry diseases. Local staff will be trained to conduct the extension package, and these activities will be expanded into new sites.

Objective 9: To evaluate the extension activities conducted to date and to modify extension materials and/or extension methodologies accordingly. (Extension II)

This will be an on-going process and will involve an extension specialist, who will monitor the response of farmers to the extension messages. Changes will be made to extension materials and approaches if necessary to ensure the most effective methodologies are used.

Objective 10: To investigate the feasibility of distribution and marketing of chick starter feed to village farmers. (Extension II)

Approaches to the sustainable distribution of chick starter feed to village farmers will be assessed. The delivery and marketing of commercial starter feed to farmers will be explored.

Objective 11: To improve the capacity of local veterinarians in epidemiological techniques, building on training conducted in the original project and including broader training on disease surveillance methodologies. (Extension II)

This will reinforce the training conducted in the original project and will be expanded to include capacity building in the broader area of disease surveillance.

5 Methodology

There was an initial period of setting up the project, which involved a number of activities. A project vehicle was purchased in Australia and shipped to Myanmar. This was a major accomplishment as imports of new vehicles are usually not possible in Myanmar. This project vehicle allowed project activities to be carried out more effectively. In particular, visits by project staff to field sites and collection of samples could be facilitated by the use of a reliable vehicle. A project office was established in the central building of the Livestock Breeding and Veterinary Department (LBVD) at Insein, Yangon. The LBVD organised refurbishment of the office. Office equipment was purchased, an air-conditioner installed and the project purchased laptop and desktop computers for use by project staff. An internet connection to the project office was set up. This was a major achievement for the project and allowed the project to have its own internet account and its own email address. It addressed the potential communication problem that was identified on the initial visit to Myanmar by Dr John Copland and Dr Joanne Meers in August 2002.

In the following an overview of the methodology applied to each objective is provided.

Objective 1: To enhance the production, quality and distribution of thermostable Newcastle disease vaccine in Myanmar.

Eleven participants representing the central (Yangon) vaccine production laboratory and eight regional laboratories (Sittwe, Pathein, Magway, Myitkyina, Pyin Oo Lwin, Mon Ywa, Taung Gyi, Hpa-An) of the LBVD attended a 7-day course on Newcastle disease vaccine production and quality control. The training course was held in Pyin Oo Lwin in June 2005 and conducted by Joanne Meers and Zuhara Bensink. Participants were trained in a variety of techniques associated with the production and quality control of vaccines, including egg inoculation, titrations, serological assays, sterility testing, record-keeping and problem–solving. The participants gained knowledge and experience, which will help in producing a high-quality I-2 Newcastle disease vaccine.

Items of laboratory equipment and materials were purchased for the LBVD vaccine production laboratories and diagnostic laboratory. These items included hand crimpers, self-refilling laboratory syringe pipettors, multichannel pipettors, single pipettors, candling lamps, antigens and control sera, cryotubes, pipette tips, and microbiological media, and were purchased in Australia and transported to Myanmar by project personnel. These devices will help to ensure a high quality production of I-2 vaccine and allow a better diagnostic description of vaccine and field viruses.

Two refrigerators for both veterinary township offices and cool boxes (eskies) for every enumerator participating in the study (n=10) were purchased for vaccine storage and distribution in the project villages. This allowed appropriate vaccine storage in the township offices and reduced the exposure of vaccine to high environmental temperatures in the field.

Data loggers were also obtained and taken to Myanmar to monitor the exposure of vaccine virus to environmental temperatures and to prove constancy of temperatures in the refrigerating systems of the laboratories. Field veterinarians used these devices in their cool boxes during vaccine distribution accompanied with recording sheets on the actions taken during vaccine distribution. These data were evaluated and concerns relating to the transport of the liquid vaccine and to maintaining a cold chain were identified.

Objective 2: To develop appropriate extension materials to enhance sustainable usage of Newcastle disease vaccines and to improve the capacity of government staff in extension methodologies.

In November 2003, Dr Henning conducted a training session on the extension technique of interviewing and collecting questionnaire data from village households.

For the intervention study an extension pamphlet describing the management changes and different causes of mortality in village chicken based on the data collected in the baseline studies was developed and was distributed to households where management changes were incorporated.

A folded extension pamphlet describing the use of I-2 vaccine to protect birds from Newcastle disease was developed to be distributed to farmers and their children to increase their awareness on the use of the vaccine.

A one sheet calendar for 2006 (showing a vaccination calendar with a Myanmar actress) and a 12-page calendar using the cartoons developed in the project was produced and distributed to farmers, field veterinarians, village head men and NGO's.

Several local artists were hired to draft pictures and cartoons outlining the advice given to the farmers in regards to improving village chicken health. An understanding of the images, the clarity of the message to be told and the sequence of the pictures shown was tested during farmer meetings. Several meetings were conducted with the artists, veterinarians and farmers to produce the most appropriate extension messages.

Drawings were coloured using computer software and a publishing company was approached for the printing of several extension materials (only some of them are described in the following in detail). All extension materials were designed on the basis of the results from the scientific investigations.

- A large number of extension materials was developed covering a wide area of topics relating to village chicken health. For example, a poster and a booklet on Avian Influenza were developed. The poster is in A2 (15x20 inches) size and printed in colour. The text is in Myanmar, but some of the headings are in also in English. A total of 1000 copies were produced. The coloured poster includes a section describing Avian Influenza virus (AIV) as the cause of disease, ducks as the probable hosts for AIV and the virus' potential to infect other species. Different transmission ways to spread AI virus are shown as well. Another section focuses on biosecurity measures showing the fencing of farms, the removal of droppings, the separation of sick birds and prevention of people entering farms. In a few cartoons situations that should be avoided are shown, including cock fighting and the throwing of dead birds into waterways. The handling of birds in a case of an AI outbreak is also shown. Facemasks need to worn by workers and dead birds need to be discarded safely by burning or burying cadavers. Finally measures to prevent the spread of AIV infection to humans are explained, which include prevention of children playing with chickens, proper washing of hands etc. It is also advised that in case of any flu like symptoms in humans a medical doctor should be consulted. A 36-page A5 booklet explains all the information given in the poster in more detail, and incorporates additional sections on symptoms of AI infection, different levels of biosecurity measures and detailed advice on how to prevent infection in humans. All pictures from the poster plus additional cartoons are included in the booklet. The text in the booklet is only in Myanmar.
- A booklet on village chicken health was developed and distributed to farmers. The booklet focuses how to obtain good biosecurity on farms and how to improve the survival rate of village chickens using I-2 vaccination and improved management. In addition awareness towards HPAI is also advocated in the booklet.

- An extension booklet on biosecurity for poultry farmers was developed. It contains information on preventing the introduction of infectious diseases to a village chicken farm. The booklet focuses on sector 3 and sector 4 chicken farmers.
- A single sheet, laminated wall calendar for 2008 (20 inches x 30 inches) was developed and distributed to farmers. Extension messages on I-2 vaccination (including a vaccination calendar) and improved chick management were summarized on the calendar. Between 500-1000 copies of this were produced.
- In addition a 12-sheet desk calendar (6 inches x 8 inches) was developed and distributed to farmers, village head men, key village people, township veterinarians, LBVD staff and national and international organizations focusing on animal health issues in Myanmar. This calendar contains extension messages and information about the ACIAR project in Myanmar.
- The coloured pictures were arranged for the production of a large flip chart which is the main tool for presentations during farmer meetings.

Drawings and cartoons developed in this project were shared with other international aid agencies and were incorporated in their extension work (e.g. WHO, FAO, UNICEF, AusAid, JapanAid etc.) Additional funding sources apart from ACIAR funding were used to produce some of the posters (e.g. LBVD, WHO).

Farmer meetings were the major tool for delivering extension messages (see details under objective 8).

Extension services on animal health did not exist in Myanmar before the commencement of this project and were developed during the course of the project (see details under objective 8).

Objective 3: To improve the capacity of government staff to diagnose the major diseases of village poultry.

A one-week workshop in diagnostic pathology was conducted by Dr Ian Wilkie and Professor Allan Frost. This course concentrated on gross diagnostic techniques complemented by appropriate and available secondary laboratory procedures. Practical classes utilised chickens as the demonstration animal, however, the principles taught were applicable to all species. The workshop was held on 8-12 December 2003 at the Diagnostic Laboratories of the LBVD, Insein, Yangon. Twelve participants attended the workshop. This included two people from the central diagnostic laboratories, two from the Veterinary Assay laboratory and eight regional field veterinarians.

A training course on the use of molecular techniques to identify agents causing poultry diseases was conducted in February 2004 by Dr Myat Kyaw-Tanner. Six scientists participated in the workshop: four from the Central Diagnostic Laboratory, one from the assay laboratory and one from the viral vaccine production laboratory. Laboratory equipment for molecular techniques, including a PCR machine (thermocycler) and electrophoresis equipment was also supplied. This course trained LBVD staff to use advanced molecular tools for the diagnosis of avian diseases.

An ACIAR-funded training workshop on the serological diagnosis of H5N1 avian influenza and Newcastle disease (included in a workshop on production and quality control of I-2 ND vaccine) was held in Laos in June 2004 with two participants from Myanmar. This increased the capacity of these Myanmar scientists to diagnose other emerging poultry diseases.

Epidemiological techniques for disease outbreak investigations, analysing and summarizing epidemiological findings were taught by Dr Joerg Henning during a

workshop in October 2006. A total of 19 participants included all members of the epidemiology group in LBVD, researchers from the biochemistry, virology and parasitology laboratories in LBVD, participants from the labs in Magway, Pyin Oo Lwin, Taunggyi, Pathein and Mangwa. In November 2007 Dr Joerg Henning conducted a computer based data management and data analysis course using Microsoft Excel in Yangon with participants from the labs in Magway, Pyin Oo Lwin, Taunggyi, Pathein and Mangwa.

Further training of collaborating scientists (Wai Zin Thein, Nilau Kyaw) in molecular techniques and in veterinary epidemiology was provided during their visit at the University of Queensland in April 2005. This improved the capacity of the LBVD diagnostic laboratory worker (Wai Zin Thein) to diagnose poultry diseases and provided additional epidemiological expertise to the other LBVD staff member (Nilau Kyaw).

Objective 4: To determine the major constraints on the production of village poultry in Myanmar, to specifically evaluate the impact of Newcastle disease and the effect of vaccination.

Under the supervision of Dr Joerg Henning epidemiological investigations were divided into two stages: baseline studies to collect background data and an intervention study with interventions directly resulting out of the findings from the baseline studies.

Baseline studies

A baseline survey and a longitudinal panel study were conducted to investigate constraints on poultry production in villages in Myanmar and to determine the impact of Newcastle disease. Prior to his first visit to Myanmar in October/November 2003, Dr Henning had discussions with other project personnel, including Dr Rutherford (agricultural economist), Dr Wilkie (pathologist), Dr Meers and Prof Spradbrow (virologists) and Dr Pym (poultry production specialist) on the design of a questionnaire that would form the basis of the survey. Drafts of two questionnaires (one to be used for an initial interview in the baseline survey and the other for the monthly data collection in the longitudinal panel study) were produced. During the visit in October 2003 by Drs Henning, Meers, Pym and Rutherford, the survey strategy was discussed and modified with input from project personnel in Myanmar. The baseline questionnaire was tested in a pilot trial in four selected households. Based on results, several questions were modified, the questionnaire was shortened and other changes made to simplify the interview process.

Ten villages were selected for inclusion in the baseline studies. These villages were purposively chosen by staff from the Livestock Breeding and Veterinary Department of Myanmar based on the following criteria: 1) the village had to be in an area with veterinary services capable of conducting the data collection, 2) the village must have had households that were chicken farming using the typical Myanmar village chicken back-yard production system, and 3) a permit to conduct frequent visits was obtainable for the village. In addition, villages were selected to ensure that study villages were located throughout the whole Yangon division (up to 80km north and 30km south of Yangon). Vaccination against ND had never been conducted in any of these villages and was not practised during the study. No vaccinated birds were purchased and incorporated into the study flocks during the study. For all 10 villages, field veterinarians prepared lists of all households that owned chickens showing the number of chickens within each household. This list of households enumerated the entire target population, and was used as a sampling frame. Sample size for estimating the prevalence of ND antibodies was calculated based on two stage sampling, with household flocks selected at the first stage and chickens selected at the second stage. The outcome of interest was defined as bird-level prevalence of ND antibodies in unvaccinated village chicken flocks. A total number of 307 households were sampled, from 10 villages in two separate townships (one north and one south of Yangon). Samples from four chickens per household were required.

During the October/November 2003 visit, an information session was held, attended by all of the field veterinarians, district and township veterinary officers and staff from the LBVD who would be involved in the survey. The questionnaires were explained, and a practical exercise was held to instruct on methods for collection of blood samples from chickens. Field veterinarians were supplied with equipment for collection and storage of blood samples, copies of the questionnaires and general instructions on the survey procedure.

In November 2003 the longitudinal panel study commenced. Six English- and Myanmar-speaking field veterinarians were trained to conduct face-to-face interviews with the farmers. Interviews were conducted in Myanmar and answers recorded in English into the questionnaire. Each household was visited approximately monthly over a period of 6 months, from November 2003 until May 2004. Blood samples were collected for the detection of antibodies against Newcastle disease virus from four chickens at each household visit. Two adults and 2 growers were sampled in each household. The haemagglutination inhibition test was used to measure the antibody titre against Newcastle disease virus. Any deaths were investigated and diagnosis of the cause of death made (by post-mortem examination and PCR) wherever possible and virus isolation was attempted. Surveyed farmers and village head men received gifts (soap, metal plates and traditional clothing) to acknowledge their participation in the study.

Results of the baseline studies were presented internationally and in Myanmar and were incorporated in the extension material developed. The outcomes of this work led to the treatments applied in the intervention study.

Intervention study

This study consisted of a series of controlled trials conducted in 9 villages in two different locations N and S of Yangon, (Tai Kyi township and the Than Hlin/Khautan township). Households with village chickens were selected for this study. Village chickens were kept in their normal environment and monitored over a period of 12 months to account for seasonal effects. Data collection was conducted from July 2004 until July 2005. The intervention strategies (hereafter referred as treatments) were applied at the household level. Households were assigned to one of three treatment groups: I-2 vaccination applied every three months to selected individual birds within the household, placebo vaccination applied every three months to selected individual birds within the household and changes to the management of chick rearing applied to all chicks within the household.

A sampling frame containing all chicken owning households with more then 25 birds was developed. Information on the total number of chickens was available for every household; therefore a probability proportional to size sampling was used, with households with a larger number of chickens having a higher chance of being selected. A total of 160 households in 12 villages were selected for this study.

The ‘wet’ form of a thermostable I-2 vaccine was used for vaccination against Newcastle disease. This vaccine was produced in the vaccine production laboratory of the Livestock Breeding and Veterinary Department in Yangon, Myanmar. The vaccine vials were stored in refrigerators in the township veterinary offices and transported into the field in cool boxes (eskies) filled with ice. The same preparation procedure as applied for I-2 production was used to prepare the placebo, but no active Newcastle disease vaccination virus was included. The vaccine and placebo were administered by the field enumerators/field veterinarians. Farmers and Veterinarians were not informed that birds did not receive any I-2 vaccine. Within households birds were selected and wing-tagged to allow identification of individual birds. The monitoring of individual marked birds allowed a follow-up of antibody levels. Marked placebo vaccinated control birds within the same flock were also followed-up individually.

The specific management procedures were developed to allow a high level of protection of chicks and to produce a better nutritional status of chicks during their early growing period. Management changes were applied over a period of six weeks, as follows:
In the first week after hatching chicks were reared confined with the hen. Chicks had no access to the yard or fields during this period. They were kept under locally-produced bamboo coops. In creep feeders under the bamboo coops supplementary fed was provided to chicks, but could not be reached by the hen. In the second and third week chicks had access with the hen to the surrounding environment at daytime but were confined at night with the hen. As the size of the chicks increased, chicks from 3 to 6 weeks of age were confined at night by themselves, and they were scavenging freely during daytime.

Trained field veterinarians visited farms monthly and recorded changes to the chicken population structure, mortalities, sales, consumptions and hatchings. In addition information on weekly changes in mortalities, sales and consumption of individual batches of chickens was recorded by farmers. Blood samples were collected from selected wing-tagged birds to allow the monitoring of individual bird antibody titres against Newcastle disease virus. Any deaths were investigated and diagnosis of the cause of death made (by post-mortem and PCR) wherever possible and virus isolation was attempted.

Rapid Rural Appraisal

The objectives of this work were to evaluate village chicken production and trade in two areas of Myanmar, with different climatic characteristics and to describe farmers' opinions on the major limitations to village chicken production and on Newcastle disease vaccination. Participatory rural appraisal techniques (PRA) were used to gather information and involve all key professions involved in village chicken health, trade and production.

Two divisions with large village poultry sectors and in two different climatic zones were selected for this study (Yangon and Mandalay Division). Typical PRA methods such as semi-structured interviews and direct observations were conducted to gather information on practices of village chicken production.

Individual interviews were conducted in January 2004 and focused on areas of importance in village chicken production, chicken mortality, Newcastle disease vaccination and chicken trade. Key informants included all community members involved in village chicken production (chicken farmers, chicken traders, veterinarians). Similar questions were used in the interviews with different key informants, but additional questions were asked specific to the profession of the interviewee. All interviews were conducted in Myanmar language and lasted between 20-40 minutes. Interviews were carried out in the village environment, either outside or within the interviewee's house. Households were chosen randomly during transect walks through the village: usually two households within a village were chosen from two distant parts of the village. One 'richer' and one 'poorer' chicken owning household were selected, based on the size of the house and the material used for the house construction. Information gathered was discussed with interviewees to identify areas for improving village chicken production.

Direct observations of chicken flocks, chicken husbandry and interviewee's behaviour during the interview were used to modify the questions asked.

Objective 5: To genetically characterise field isolates of Newcastle disease virus from Myanmar and to confirm the efficacy of I-2 vaccine against these isolates.

Equipment for molecular studies was purchased and transported to Myanmar on a number of visits.

Laboratory personnel were trained in the genetic characterization of virus isolates using reverse transcriptase polymerase chain reaction (PCR) in Yangon in February 2004 by Dr Myat Tanner. A total of five participants attended this course. In addition, laboratory equipment for conducting molecular techniques was supplied during this visit.

Further training of a visiting scientist (Wai Zin Thein) in molecular techniques was conducted in April 2005 at The University of Queensland in Brisbane/Australia.

Field isolates of Newcastle disease virus were collected from the village survey in Objective 4 and from other cases of Newcastle disease that were brought to the attention of the participating staff. Viral RNA was extracted from these isolates and reverse-transcriptase PCR using primers for the F and HN genes of Newcastle disease virus was performed. Sequencing reactions were then performed on the samples and the amplified DNA from these reactions was transported to UQ for sequencing and phylogenetic analysis in 2005. Sequences were aligned and analysed in 2006 and the results of this phylogenetic analysis were presented at two meetings in Myanmar in 2007, including a paper at the Myanmar Veterinary Association Annual meeting

Objective 6: To complete the assessment of the impact of improved chick rearing and Newcastle disease vaccination on the production and profitability of village chicken-keeping in the current field locations. (Extension I)

The data collection in the intervention study was concluded in July 2005. The “no travel to Myanmar” policy imposed by ACIAR in late 2005 made it impossible to obtain the data during a visit that had been planned for September 2005. More importantly, verification of the correctness of the data entry by comparing digitized records with the filled-in paper questionnaire records could not be conducted at the time and the Australian project personnel had to rely purely on the inconsistent email connection to solve data problems. Data analysis was conducted at the University of Queensland by Dr Joerg Henning.

To consider the characteristics of the data (clustering within households, monthly sampling intervals, two distinct study groups with individual vaccination and complete flock vaccination) different analytical approaches were developed, tested, improved and finalized. General Estimation Equation (GEE) models for longitudinal data were the most frequently applied analytical procedure. The data were analyzed and a 40-page report was supplied to ACIAR in December 2005.

The most cost-effective strategy and the best cost-recovery system for sustainable Newcastle disease control and chicken management were identified. The impacts of single interventions and combinations of interventions were compared. The impact of the intervention strategies under different seasonal conditions was assessed.

Objective 7: To improve the capacity of local veterinarians in epidemiological techniques to investigate and control poultry and other animal health problems under local conditions. (Extension I)

Personalised training of LBVD staff in Veterinary Epidemiology

During frequent visits of Dr Joerg Henning to Myanmar LBVD staff was introduced data management, work with databases, data analysis, questionnaire design and surveillance techniques and other facets of epidemiology. Epidemiological literature and software were supplied and LBVD staff was trained and supported.

Workshops in Veterinary Epidemiology and Data Analysis

Workshops in epidemiological techniques to investigate and control poultry and other animal health problems under local conditions were conducted by Joerg Henning to train Myanmar veterinarians in conducting their own investigations into animal health problems

using scientific approaches and to assist in the development of surveillance methodologies.

Further training of LBVD staff in Veterinary Epidemiology

After the introduction to epidemiological techniques, two key personnel (Nilau Kyaw, Yin Yin Thein) at LBVD attended international training courses in Veterinary Epidemiology in Thailand, organised by the Free University of Berlin.

Training in Veterinary Epidemiology at the University of Yezin, Myanmar

The inclusion of training in Epidemiology in the curriculum of Veterinary Studies in Myanmar was suggested, discussed and is planned to be incorporated. Guest lectures at the university by Dr Joerg Henning in Veterinary Epidemiology were requested by the Director General of LBVD in a possible extension period of the project.

Objective 8: To expand the extension activities commenced in 2005/2006 beyond the original study site areas and incorporating broader aspects of chicken health. (Extension II)

An extension specialist, Jo Crosby, was employed to improve the extension work in Myanmar. A visit in February 2007 was organized and the following tasks were conducted by the extension specialist:

- A two-day workshop on extension methods was held for veterinarians from the Livestock Breeding and Veterinary Department (LBVD) and for field veterinarians:
  - Lectures and exercises on public communication and extension methods
  - Training in methods to disseminate information on village chicken health
  - Provide advice on how to establish extension services within LBVD (there are no specific extension services currently existing within LBVD)
  - Prepare handouts of lectures to LBVD and the ACIAR project.
- The extension material and the extension messages already produced within the village chicken project were evaluated.
- A farmer workshop with project personnel on village chicken health using existing extension material was conducted.
- A report was written evaluating the extension workshop, the existing extension materials and the farmer workshop conducted, giving recommendations for further project activities and for the establishment of extension services within LBVD (the extension specialist's report was provided to ACIAR separate to this final report).

Workshop on extension methodology

Details on this 2-day workshop are provided in Appendix 1. No extension services existed within LBVD prior to the project and this workshop aimed to stimulate the development of such a service for livestock health in Myanmar. Participants came from throughout Myanmar, with representatives from seven states and divisions invited to attend.

Structure of extension services

The extension specialist provided advice on the establishment of livestock health extension services in LBVD. Details of model that was developed are given in Appendix 1.

Guidelines for farmer workshops on village chicken health

The extension specialist assisted with the development of guidelines for farmer workshops on village chicken health. The plan was that these workshops would be conducted by a field veterinarian along with the key person of the selected village. Discussions with farmers on village chicken health would be an important part of these farmer meetings. Details of the guidelines that were developed are provided in Appendix 1.

Expansion of extension work in other villages and regional areas

Visits to the Regional Veterinary Offices in the Ayarwadi and Mandalay Division and in The Shan State were conducted to promote the extension work. Flip charts and other extension material was distributed to the veterinary offices and township and field veterinarians trained in delivering the extension messages.

Objective 9: To evaluate the extension activities conducted to date and to modify extension materials and/or extension methodologies accordingly. (Extension II)

This was an on-going process and involved an extension specialist, who monitored the response of farmers to the extension messages and frequent farmer meetings in which the quality and easy interpretation of the extension messages was discussed (see objective 8). Changes were made to extension materials and approaches if necessary to ensure the most effective methodologies were used.

Evaluation of farmer workshop and extension material by extension specialist

The extension specialist commented that the farmer workshop was well structured and logical, and the messages were clear and it was well received by farmers present. The flip chart was assessed to be excellent, using cartoons to illustrate the talk. The large size of the flip chart (approximately 2m x 1m) ensured that all could see it, and eliminated the need for electricity to drive a data or overhead projector. The simple, robust vinyl construction of the flip chart enables it to be used many times without damage. The distribution of management equipment at the conclusion of the meeting ensured that the farmers left feeling positive about the meeting and the project. Furthermore the extension specialist commented that the pamphlet reinforced the messages introduced at the meeting.

The extension specialist commented that the cartoon style used in the extension materials enables farmers easily to understand their messages regardless of the level of literacy, and their distribution provides reinforcement of the messages promoted at the farmer meetings. The adoption of some of the cartoons by other agencies is an indication of their quality and utility.

The extension specialist indicated that at least two years are necessary to allow for further farmer engagement and the development and implementation of an evaluation plan on the extension outcomes on farm level.

Alterations to farmer meetings

As the responsibility for managing village chickens is often borne by women, it was important to engage them at meetings if the recommendations are to be adopted. If it was difficult to gather women together in the village for meetings it became necessary to be creative about communicating the project outcomes and recommendations to them.

Farmers take notice of trusted peers and the use of advocates increases their confidence in any proposed practice change. These farmers were used to deliver some of the messages. Including the opportunity for a farmer who has adopted all or some of the recommendations of the project did enhance the learning outcomes of the farmer meetings. An experienced farmer is able to describe the practical implications of making a change and answer any questions.

Objective 10: To investigate the feasibility of distribution and marketing of chick starter feed to village farmers. (Extension II)

Initially chick starter from a local feed mill in the Than Kyi township was used in the intervention study, but the poor quality of this starter feed in particular in wet season resulted in the use of commercial CP chick starter feed in the progress of the study. In general farmers were very pleased about the observed effects using starter feed. A faster

growth of chicks was regularly reported, which encouraged the adoption of the use of chick starter feed. In addition the purchase price is very affordable to farmers (in comparison to higher prices for the bamboo coop and creep feeder). However, in 2006 prices for chicken feed increased considerably following the Avian Influenza outbreaks in Myanmar.

Chick starter feed was purchased in 40 kg bags during the intervention study and repacked in 1 kg packages, which are sufficient for the supply of one batch of chicks for about 3-4 weeks. The chick starter feed in a suitable 1 kg package format is not locally available in the villages. Therefore CP chick starter feed was purchased, repackaged in 300 x 1 kg packages and distributed to farmers.

The project evaluated methods for a sustainable distribution of chick starter feed to the villages. A distribution of chick starter feed (and creep feeders and bamboo coops) focussed on the following locations:

- from animal feed traders within villages
- from township veterinary offices
- during farmer meetings
- from shops within villages.

In October 2006 a group of village merchants of animal feed and agricultural products was invited for a group discussion to LBVD to investigate the possibility to include items for village chicken management in the merchants' range of products. In addition animal feed traders were visited in February 2007 at their premises to discuss the possibility of using them as distribution centres for the management equipment promoted by the project. Farmers indicated during farmer meetings that they would have much more confidence in the product if the chick starter feed is received from the township veterinary office or during the farmer meetings.

It seemed that the use of animal feed traders for the distribution of management equipment was impracticable. These traders mainly dealt with larger flocks, they did not live in the villages (they were mainly based in the township centres) and they were therefore unlikely be contacted by village chicken farmers. They also seemed to be not very cooperative because the possible profit from the sale of equipment to village chicken farmers is small in comparison to profits made from larger customers.

Therefore it was decided that field veterinarian should identify key people who would be able distribute the equipment in the selected villages. These should become the key people on village chicken health in these villages. In addition shop owners were contacted to discuss the distribution of the equipment and feed. Incentives were paid to village chicken key people and shop owners if they sold the equipment to farmers.

Objective 11: To improve the capacity of local veterinarians in epidemiological techniques, building on training conducted in the original project and including broader training on disease surveillance methodologies. (Extension II)

Workshop in Veterinary epidemiology

A course titled 'Principles of veterinary epidemiological investigations and introduction to statistics, hypothesis testing, study design and analysis of data' was conducted in the teaching facility at LBVD in Yangon, Myanmar from 16th October to the 20th October 2006. A total of all 19 participants included all members of the epidemiology group in LBVD, researchers from the biochemistry, virology and parasitology laboratories in LBVD, participants from the labs in Magway, Pyin Oo Lwin, Taunggyi, Pathein and Mangwa.

The course combined presentations and exercises. Handouts were prepared for all lectures and exercises in English. The course covered the following topics:

- Epidemiology and causation
- Patterns of disease occurrence
- Measuring disease occurrence
- Measures of association
- Epidemiological studies, Intervention studies
- Presenting numerical data
- Probability, confidence intervals and power
- Sampling
- Diagnostic tests
- Outbreak investigations

Workshop in data analysis using computer software

A workshop titled 'Data management and data analysis using Microsoft Excel' was conducted in Yangon, Myanmar, from 22nd to 23rd November 2007. Participants included all members of the epidemiology group in LBVD, researchers from the biochemistry, virology and parasitology laboratories in LBVD, participants from the labs in Magway, Pyin Oo Lwin, Taunggyi, Pathein and Mangwa.

The course combined presentations and exercises and self-paced tutorials. Participants were introduced to the use of epidemiological software. Serological data from a Newcastle disease survey conducted by LBVD were used as example datasets for the exercises and different analytical approaches were discussed. Handouts were prepared for all lectures and exercises in English.

6 Achievements against activities and outputs/milestones

Objective 1: To enhance the production, quality and distribution of thermostable Newcastle disease vaccine in Myanmar.

no.	activity	outputs/ milestones	completion date	Comments/Achievements
1.1	Refresher course on I-2 Newcastle disease vaccine production and quality control (PC).	High quality I-2 Newcastle disease vaccine produced in central and regional laboratories, enabling distribution of vaccine to farmers throughout the country.	June 2005	Eleven participants representing all regional laboratories and the central vaccine production laboratory attended the 7-day training course on vaccine production and quality control. Participants were assessed on the development of their laboratory, problem-solving and analytical skills,
1.2	Items of laboratory equipment were purchased for the vaccine production laboratory and diagnostic laboratory (A).	To ensure a high quality production of I-2 vaccine and allow a better diagnostic description of vaccine and field viruses.	Throughout the project	At the start of the project many of the LBVD laboratories were poorly equipped and lacked basic minor equipment and reagents. The purchase of a variety of large and small items over the life of the project had a substantial impact on the ability of these laboratories to function competently.

1.3	Two refrigerators for both veterinary township offices and cool boxes for every enumerator participating in the study (n=10) were purchased (PC).	This allowed appropriate vaccine storage in the township offices and reduced the exposure of vaccine to high environmental temperatures in the field.	End 2006	Although the I-2 Newcastle disease vaccine is comparatively thermostable, optimum vaccine performance is facilitated by cool storage during transport from the vaccine production facility. Purchase of these items ensured a more effective cold chain for vaccine transport.
1.4	Data loggers were obtained and taken to Myanmar (PC).	To monitor the exposure of vaccine virus to environmental temperatures and to proof constancy of temperatures in the refrigerating systems of the laboratories.		Field veterinarians used these devices in their chilly bins during vaccine distribution accompanied with recording sheets on the actions taken during vaccine distribution. This data was evaluated and concerns relating to the transport of the liquid vaccine and to maintaining a cold chain were identified.
1.5	Investigations into the use of sealed transfer pipettes for delivery of liquid vaccine	The use of a new vaccine storage and delivery system if the trial proves successful.	2004	Experiments conducted at UQ identified several problems in this approach to vaccine storage and delivery. It was difficult to maintain sterility when sealing the pipettes and it was not possible to source a different style of pipette that was cost-effective.
1.6	Re-schedule of timing of national I-2 vaccine production and I-2 national vaccination programs (PC).	To ensure immunity in vaccinated flocks during high risk periods of ND that were identified in the epidemiological surveys.	2008	Through the epidemiological studies reported below, the most effective timing for Newcastle disease vaccination could be determined.

PC = partner country, A = Australia

Objective 2: To develop appropriate extension materials to enhance sustainable usage of Newcastle disease vaccines and to improve the capacity of government staff in extension methodologies.

no.	activity	outputs/ milestones	completion date	Comments/achievements
2.1	Evaluation of current extension materials and methodologies	The requirement for improved extension materials and extension activities assessed.	2003	In the early stages of the project it was realised that there was no defined extension section of the Livestock Breeding and Veterinary Department and there were very limited extension materials (e.g. pamphlets). The few available items were either out-dated or not Myanmar-specific.
2.2	Workshop on collection of questionnaire data from village households and stratified sampling of animal populations (PC).	LBVD staff Introduced to extension technology.	November 2003	The training course was attended by all of the field veterinarians, district and township veterinary officers and staff from the LBVD who are involved in the baseline studies. The questionnaires were explained, and a practical exercise was held to instruct on methods for collection of blood samples from chickens.
2.3	Design of new extension materials, and/or translation of extension materials developed under previous ACIAR projects	Effective extension materials produced	Throughout the project	A large number of different types of extension materials were designed and produced throughout the course of the project, as outlined below.

		2.3(i) First introduction of farmers to extension materials	May 2004	An extension pamphlet describing the management changes and different causes of mortality in village chicken was developed and distributed to farmers (PC).
		2.3 (ii) Farmers' awareness on the use of the ND vaccine increased.	2004	A folded extension pamphlet describing the use of I-2 vaccine to protect birds from Newcastle disease was developed to be distributed to farmers. The pamphlet focused on playful use by children. (PC).
		2.3 (iii) Increased awareness by farmers on the use and timing of the vaccine	2006	A one sheet calendar for 2006 (showing a vaccination calendar with a Myanmar actress) (PC).
		2.3 (iv) Information about the project was distributed to other regions and this led to development of areas of collaboration for future work	February 2005	An information pamphlet describing the different parts of the project and including data and extension material developed in the project was produced (PC). The pamphlet was distributed to institutions and organizations involved in livestock work and research in Myanmar, regional LBVD offices, field veterinarians in the study areas, University of Veterinary Science Yezin, village chicken breeding farm Bagan, FAO Yangon, and livestock-related NGO's (German Agro Action, Capacity Building Activity and others).
		2.3(v) Translation of research results into features understood by farmers.		A local artist was hired to draft pictures and cartoons outlining the advice given to the farmers in regards to improving village chicken health (PC).
		2.3(vi) Posters were used to inform, educate, and train on HPAI and good farming management methods to prevent animal and human infection.		Posters on Avian Influenza were developed (PC).
		2.3(vii) A booklet explaining all information in the avian influenza poster in more detail was produced to increase awareness about HPAI.		A booklet on Avian Influenza was developed (PC). The 36-page A5 booklet is printed in black and white with a coloured front and back cover. A total of 1000 copies of the booklet were produced. All pictures from the poster plus additional cartoons are included in the booklet. The booklet incorporates additional sections on symptoms on HPAI, levels of biosecurity measures and detailed advice on how to prevent infection in humans. The text in the booklet is only in Myanmar.
		2.3(viii) The technical aspects of the intervention study were explained to participating farmers		A fold-out A4 pamphlet showing use of coops and vaccines was designed and produced (PC).
		2.3(ix) Community informed about village chicken production & HPAI		Large vinyl flip chart using same cartoons as brochures – for use as a teaching aid in villages (PC).

		2.3(x) A new booklet on village chicken health was developed (PC).		The booklet focuses how to obtain good bio-security on farms and how to improve the survival rate of village chickens using I-2 vaccination and improved management. In addition awareness towards HPAI is also advocated in the booklet.
		2.3(xi) AusAid, Care Myanmar and LBVD pamphlet for farmers to inform about prevention and control of HPAI (PC).	2006	Other non-government agencies and the LBVD developed further extension materials based on the cartoons and text produced in the ACIAR project
		2.3(xii) AusAid, Care Myanmar and LBVD booklet for poultry farmers on bio-security and good farming practices (PC).		Other non-government agencies and the LBVD developed further extension materials based on the cartoons and text produced in the ACIAR project
		2.3(xiii)UNICEF and LBVD booklet for veterinarians on Avian Influenza infection (PC).		Other non-government agencies and the LBVD developed further extension materials based on the cartoons and text produced in the ACIAR project
		2.3(xiv) UNICEF, Japan Aid and LBVD pamphlet distributed during a public awareness campaign on HPAI (PC).		Other non-government agencies and the LBVD developed further extension materials based on the cartoons and text produced in the ACIAR project
		2.3(xv)A new extension booklet on bio-security for poultry farmers was developed (PC).	2007	The pamphlet contained information on preventing the introduction of infectious diseases to a village chicken farm. The booklet focuses on sector 3 and sector 4 chicken farmers.
		2.3(xvi) A single sheet, laminated wall calendar (20 inches x 30 inches) for 2008 was produced (PC).	2007	Extension messages on I-2 vaccination (including a vaccination calendar) and improved chick management are summarized on the calendar. Between 500-1000 copies of this calendar were produced and distributed to farmers and field veterinarians..
		2.3(xvii) A 12-sheet desk calendar (6 inches x 8 inches) was produced to increase awareness of the intervention strategies that can improve village chicken production (PC).	2007	This calendar contained extension messages and information about the current extension program conducted by the ACIAR project in Myanmar. Between 500-1000 copies of this calendar will be produced and distributed to farmers, village head men, key village people, township veterinarians, LBVD staff and national and international organizations focusing on animal health issues in Myanmar.

PC = partner country, A = Australia

Objective 3: To improve the capacity of government staff to diagnose the major diseases of village poultry.

no.	activity	outputs/ milestones	completion date	comments/achievements
3.1	One-week training workshop in diagnostic pathology (PC).	The ability of LBVD staff to diagnose poultry diseases was improved.	December 2003	Practical classes utilised chickens as the demonstration animal, however, the principles taught were applicable to all species. The workshop concentrated on the methodology of rational diagnosis with emphasis on gross pathology and microbiology.
3.2	Training course on the use of molecular techniques to identify agents causing poultry diseases (PC).	This training allowed LBVD staff to use advanced molecular tools for the diagnosis of avian diseases.	February 2004	Six scientists participated in the workshop: 4 from the Central Diagnostic Laboratory, one from the assay laboratory and one from viral vaccine production laboratory. Laboratory equipment for molecular techniques, including a PCR machine (thermocycler) and electrophoresis equipment was also supplied.
3.3	Training workshop on the serological diagnosis of H5N1 avian influenza and Newcastle disease (PC).	This has increased the capacity of Myanmar scientists to diagnose other emerging poultry diseases.	June 2004	The training course was conducted in Laos by Joanne Meers, Mary Young and Zuhara Bensink as part of an EU-funded project. Two participants from Myanmar attended the workshop, with funding from the ACIAR project.
3.4	Training of a collaborating scientist (Wai Zin Thein) in molecular techniques (A).	This improved the capacity of the diagnostic laboratory to diagnose poultry diseases, including highly pathogenic avian influenza (H5N1).	April 2005	Wai Zin conducted a series of activities in the molecular laboratory of the School of Veterinary Science at The University of Queensland, under the instruction of Myat Kyaw-Tanner.
3.5	Training of a collaborating scientist (Nilau Kyaw) in veterinary epidemiology (A).	This allows a better understanding of epidemiological situation under local conditions in Myanmar.	April 2005	At The University of Queensland under the instruction of Joerg Henning.

PC = Partner Country, A = Australia

Objective 4: To determine the major constraints on the production of village poultry in Myanmar, to specifically evaluate the impact of Newcastle disease and the effect of vaccination.

no.	activity	outputs/ milestones	completion date	comments/achievements
4.1	Selection of field sites	The most appropriate locations to conduct the epidemiological investigations of the project were selected	Mid-2003	Study villages that were representative of village chicken farming systems were selected following discussions between Australian and Myanmar project staff. Other considerations included the logistics of travel and access to the villages, and availability of field staff to participate in the studies.
4.2	Design of questionnaires for baseline studies (PC).	Drafts of two questionnaires (one to be used for baseline survey and the other for monthly data collection) were produced.	October/ November 2003	Involvement of different people with different fields of expertise: Joerg Henning (epidemiologist), Dr Rutherford (agricultural economist), Dr Wilkie (pathologist), Dr Meers and Prof Spradbrow (virologists) and Dr Pym (poultry production specialist).

4.3	Pilot testing of the questionnaires in selected households (PC).	The questions were evaluated to ensure their understanding by the farmers.	November 2003	Conducted in several households in the Yangon division.
4.4	Training in data collection and interviewing for baseline studies (PC).	This ensured a high quality of the data collected.	November 2003	Attended by all of the field veterinarians, district and township veterinary officers and staff from the LBVD who were involved in the survey.
4.5	Longitudinal panel study (PC).	This the key epidemiological study to identify major constraints to village chicken production	November 2003 – May 2004	307 households were sampled, from 10 villages in two separate townships (one north and one south of Yangon) in Yangon Division.
4.6	Data analysis of baseline studies (A).	This was important for the design of the following intervention study.	May 2004 – July 2004	
4.7	Training in data collection and interviewing for intervention study (PC).	This ensured a high quality of the data collected.	May 2004 – July 2004	Attended by all of the field veterinarians, district and township veterinary officers and staff from the LBVD who will be involved in the survey.
4.8	Intervention study (PC).	Interventions evaluated in series of controlled trials: I-2 vaccination against ND and improved chick rearing.	July 2004 until July 2005	A total of 160 households in 12 villages are involved in this study and data are collected by field veterinarians and data are collected in monthly intervals.
4.9	Data analysis of intervention study (A).	Strategies with the potential to improve village chicken production were identified.	July 2005 – December 2005	Results were incorporated into the extension messages.
4.10	Rapid Rural Appraisal on village chicken trade (PC).	To evaluate village chicken production and trade in two areas of Myanmar, with different climatic characteristics.	January 2004	Conducted in the Yangon and Mandalay Division.

PC = Partner Country, A = Australia

Objective 5: To genetically characterise field isolates of Newcastle disease virus from Myanmar

no.	activity	outputs/ milestones	completion date	Comments/achievements
5.1	Training of staff in molecular techniques (A)	Myanmar laboratory staff gained the skills required to conduct molecular techniques, e.g. PCR	February 2004 & April 2005	A one-week training course with 5 participants was conducted in Feb 2004 by Myat Kyaw-Tanner to introduce molecular techniques to the LBVD diagnostic laboratory. One staff member (Wai Zin Thein) had further training in molecular techniques during a visit to UQ in April 2005
5.2	Isolation of Newcastle disease isolates and amplification of F and HN genes (PC)	Myanmar isolates of Newcastle disease virus were amplified by polymerase chain reaction	2004- 2006	Staff in the LBVD diagnostic laboratories obtained samples from chickens suspected of dying from Newcastle disease, both from our study sites and from other disease outbreaks. The samples were inoculated into eggs, and the staff were then able to successfully amplify fragments of the F and HN genes of NDV.

5.3	Sequencing and phylogenetic analysis of PCR products	Myanmar isolates of Newcastle disease virus were characterised genetically	2007	The amplified PCR products were transported to UQ and were sequenced and the Animal Genetics Laboratory at UQ. Sequence data was analysed by Dr Jennifer Seddon of the UQ vet school. The Myanmar isolates of ND virus were found to cluster within genotype VII but were distinct from other isolates.
5.4	Equipment for molecular studies was purchased and transported to Myanmar (A).	The infrastructure necessary to conduct molecular diagnostic procedures was established at the LBVD diagnostic laboratory.	October 2003-December 2006	The molecular equipment and skills obtained by staff of the diagnostic laboratory proved invaluable when the outbreak of HPAI first occurred in Myanmar. Without these outputs from the ACIAR project, Myanmar would not have been able to rapidly diagnose HPAI and to participate with other countries in the molecular diagnosis of HPAI.

PC = Partner Country, A = Australia

Objective 6: To complete the assessment of the impact of improved chick rearing and Newcastle disease vaccination on the production and profitability of village chicken-keeping in the current field locations (extension I).

no.	activity	outputs/ milestones	completion date	comments/achievements
6.1	Assessment of intervention strategies (A).	Analysis of data obtained in the intervention study was completed. Scientific articles were drafted.	31/06/2006	The results were published internationally and presented at three international epidemiology and poultry conferences.

PC = Partner Country, A = Australia

Objective 7: To improve the capacity of local veterinarians in epidemiological techniques to investigate and control poultry and other animal health problems under local conditions (extension I).

no.	activity	outputs/ milestones	completion date	comments/achievements
7.1	Further training in Veterinary Epidemiology (PC).	Key personnel in the epidemiology group of LBVD have been further trained and supported.	Throughout the project.	Key epidemiological personnel at LBVD have enrolled in further postgraduate studies. The inclusion of training in Epidemiology in the curriculum of Veterinary Studies in Myanmar was suggested and discussed.
7.2	Training in methods to investigate disease occurrence in Myanmar (PC).	Workshop on 'Principles of veterinary epidemiological investigations and introduction to statistics, hypothesis testing, study design and analysis of data' was conducted	November 2006	Participants from LBVD Yangon, regional LBVD centres and field staff attended the workshop.
7.3	Data management and data analysis using Microsoft Excel (PC).	Participants were introduced to the use of epidemiological software.	November 2007	

PC = Partner Country, A = Australia

Objective 8: To expand the extension activities commenced in 2005/2006 beyond the original study site areas and incorporating broader aspects of chicken health (extension II).

no.	activity	outputs/ milestones	completion date	comments/achievements
8.1	Training workshop in extension methodology and dissemination of information (PC).	Capacity building in the broader area of project planning, extension skills and disease awareness.	February 2007	Veterinary staff from LBVD in Yangon and regional LBVD centres participated in the training.
8.2	Development of extension materials (PC).	Production of flip charts, pamphlets, posters on village chicken health.	Throughout the project.	Extension material has been produced. However, based on comments by farmers and field veterinarians, modifications and improvements are being continuously conducted.
8.3	Development of sustainability in extension work (PC)	Identification and training of key village personnel on village chicken health issues	ongoing	Key village chicken personnel will eventually take over most of the extension work.
8.4	Training of field veterinarians and key village people in delivering extension messages on village chicken health (PC).	Conducted through project personal and LBVD.	2006-2007	
8.5	Farmer workshops on village chicken health issues (PC).	Meetings involving farmers and LBVD staff and field veterinarians are conducted to discuss village chicken health issues.	ongoing	A plan to hold regular farmer meetings was developed and is followed over time.
8.6	Sale of bamboo coops, creep feeders and starter feed (PC).	Conducted mainly through key people, field veterinarians	ongoing	
8.7	Expansion of extension work into different regions (PC).	Involvement of 47 villages in the three Divisions in the extension work.	September 2007	In addition, the LBVD offices in the Mandalay Division and the Shan State were visited and the extension work on village chicken health was promoted.

PC = Partner Country, A = Australia

Objective 9: To evaluate the extension activities conducted to date and to modify extension materials and/or extension methodologies accordingly (extension II)

no.	activity	outputs/ milestones	completion date	comments/achievements
9.1	Evaluation of extension activities (PC).	Assessment of extension methodology by a extension specialist	February 2007	Positive feedback was provided on all extension activities. Recommendations were given to continue extension work.

PC = Partner Country, A = Australia

Objective 10: To investigate the feasibility of distribution and marketing of chick starter feed to village farmers (extension II).

no.	activity	outputs/ milestones	completion date	comments/achievements
10.1	Discussion with farmers on equipment they prefer (PC).	The most appropriate equipment was determined	2003-2006	Modification of bamboo coops and creep feeders based on experiences by farmers who used them.
10.2	Sale of commercial chick starter feed to village farmers (PC).	Chick starter feed directly supplied through ACIAR project at subsidized prices.	2005-2007	Chick starter feed was previously not available within the village chicken environment; farmers welcomed the opportunity to purchase the chick starter feed.
10.3	Investigating opportunities for a sustainable distribution of commercial chick starter feed to village farmers (PC).	The most suitable approaches to continued supply of chick starter feed determined.	2005-2007	Discussions were held at farmer meetings
10.4	Discussion with animal feed traders at LBVD (PC).	To discuss distribution of chick starter feed to villages.	October 2006	
10.5	Animal feed traders were visited at their premises (PC).	Feasibility of using animal feed traders for supply of management equipment assessed	February 2007	Animal feed traders were visited to discuss the possibility of using them as distribution centres for the management equipment promoted by the project.
10.6	Sale of management equipment through key village people and veterinarians (PC).	Development of extension service through ACIAR project.	Since February 2007, ongoing.	Sustainable, ongoing after project completion, initially subsidized with incentives paid to key village person and veterinarian

PC = Partner Country, A = Australia

Objective 11: To improve the capacity of local veterinarians in epidemiological techniques, building on training conducted in the original project and including broader training on disease surveillance methodologies (extension II).

no.	activity	outputs/ milestones	completion date	comments/achievements
11.1	Training in methods to investigate disease occurrence in Myanmar (PC)	Workshop on 'Principles of veterinary epidemiological investigations and introduction to statistics, hypothesis testing, study design and analysis of data' was conducted	November 2006	Participants from LBVD Yangon, regional LBVD centres and field staff attended the workshop.
11.2	Data management and data analysis using Microsoft Excel	Participants were introduced to the use of epidemiological software.	November 2007	

PC = Partner Country, A = Australia

7 Key results and discussion

7.1 Key results

Village Chicken Production Systems in Myanmar[8,9]

1. Commercial indigenous chicken production is practiced in Myanmar, but family poultry farming dominates the indigenous chicken production in the country [8] The project confirmed the significance of village chicken to rural farmers in Myanmar, with chicken-keeping being ranked as their second most important wealth producing activity behind crop production[9]. Chickens were raised mainly for small disposable income and were generally sold when money was needed, in particular during religious festivals.
2. There is a variety of professions working with village chickens, which include farmers, veterinarians and chicken traders. Chicken traders on bicycles, often called 'middle men', play a very important part in the trading of village chickens. These middle men usually purchase birds from farmers in about 10 villages per day. Several 'middle men' supply birds to wealthier chicken merchants, who sell these birds at larger chicken markets.
3. There is in general a limited knowledge about the prevention of Newcastle disease via vaccination amongst farmers[8].
4. The breeding and training of fighting cocks was practiced often in the Mandalay division with well trained birds sold for very high prices[8].
5. The average flock size in villages in the Yangon district was 30 birds (SD 18 birds), with a minimum of 0 and maximum of 78 birds kept within a flock in November 2003. An average flock consisted of 12 chicks, 12 growers, 4 hens and 2 cocks. Flock sizes varied over time, with more birds present 6 months earlier in May 2003[7].
6. About 98% of interviewed families (n=287) kept local chicken breeds. About 70% of farms (n=206) kept one single breed and 28% (n=82) of farms had two breeds. The most popular breeds kept were Sittagaung kept by about 91% of farmers (n=270), followed by Taik Kye (21% of farms, n=61). Other local breeds kept were Tanyin (7%, n=21), Hle pyaung (2%, n=5), Rhode Island Red cross breeds (1%, n=2) and some other breeds (mainly Malaysian cross-breeds, mainly kept as cocks).
7. The most important poultry species beside chickens were ducks (22% of farmers, n=66), with most farmers keeping 1-5 ducks (n=41) and only 25 farmers keeping more than 5 ducks. Turkeys were kept by 3% of farmers (n=10), while 3% of farms kept also geese (n=9). No pigeons, quail or other poultry were kept on any of the farms visited.
8. Regarding future plans for chicken keeping, 87% of farmers (n=258) indicated that they would like to increase the number of chickens kept, 8% (n=24) indicated they planned to maintain the same flock size and 5% (n=14) had no specific future plans for chicken keeping (category 'don't know').
9. Chickens were nearly always provided with supplementary feed; only in 1% of cases (n=2) was no supplementary feed supplied. Where chickens were supplied with supplementary feed (n=286), feed was supplied in 96% of cases daily (n=275), the rest supplied feed only a few times per week. Similar results were maintained for watering of chickens, with only 1% of farmers not supplying water (n=2). Again, of the farmers supplying water (n=284), 96% supplied it daily (n=273) and the remaining proportion only a few times per week.
10. The main supplementary feed was rice, supplied by 91% of farmers (n=295). Within the group of households where broken rice was supplied as a supplementary feed, the mean amount of broken rice supplied per bird per day was 0.0152 viss (95% CI 0.0136-0.167) or 24.8 gram per bird per day (1 viss≈1.6329kg).

11. A total of 33% of farmers (n=97) supplied food scraps to their birds, with a mean amount of 0.0058 (95% CI 0.0043-0.0073) viss per bird per day or 9.5 gram per bird per day. Rice bran or peas were not supplied as supplementary feed in any of the villages surveyed.

12. Age related feeding was conducted by less than 1% (n=1) of farmers. In only 1% of cases (n=2) was supplementary feed purchased.

13. Assessing 293 responses, a total of 68% (n=200) farmers keep their birds overnight under the house, 29% (n=86) inside the cowshed and 1% (n=4) in a separate shelters for birds. In 1% of cases (n=3) birds rested overnight in trees. Of the 4 households that provided separate shelters for birds, only one was used as a permanent shelter, while the other three were only used as an overnight shelter. The main material used for shelters was bamboo for the walls (or the floor) and Nipah palm leaves for roofing.

14. In 98% (n=290) of cases, nests for laying and brooding were provided. In most cases a bamboo basket was used as a nest (n=279), but also wooden boxes (n=6) or cane baskets (n=3) were supplied. Rice straw was usually provided as bedding for the nests.

15. On average, eleven minutes were spent daily by household members for feeding and watering chickens, including the cleaning of troughs. Considering 286 valid responses, the main person conducting feeding, watering and cleaning of troughs were women (78%, n=223). In 19% of cases (n=55) men and in 3% (n=8) children managed the chickens. The average age of a female adult person feeding chickens was 39 years (95% CI 38-41 years), of a male adult person 39 years (95% CI 37-42 years) and of a child 13 years (95% CI 12-14 years). About 40 minutes were spent per month for building nests for hens and this was also predominately conducted by woman (81%).

16. From an average of twelve eggs produced per batch, one egg was consumed or lost and eleven eggs were set under the hen. Farmers indicated that from about ten hatched chicks, approximately eight survived up to two months of age.

17. Overall a large proportion (93%, n=276) of farmers ate their own chicken meat. Home grown chicken was consumed in all villages, but the amount of meat consumed differed between the 10 villages (Kruskal Wallis test, Chi-square=148,144, df=9, $p<0.001$). The amount of home-produced chicken meat was not normally distributed. The median amount of home-produced chicken meat consumed was 5 viss (95% CI 4-9 viss) or 8.1kg per household per year. In only 7% of households (n=21) and in only 4 of the 10 villages visited, purchased chicken meat was consumed.

18. Home-produced eggs were only eaten in 7% of households (n=20), while purchased eggs were eaten in 18% (n=53) of households. The average purchase price for eggs was 36 Kyat per egg (95% CI 24-38 Kyat). Considering only households eating eggs, the median amount of home-produced eggs consumed per year was 20 eggs (95% CI 10-30) and the median amount of purchased eggs consumed per year was 30 eggs (95% CI 20-30).

19. Chicken meat was eaten by all family members. Within 84 households specifying egg consumption, in 85% households all family members ate eggs, in 14% of households eggs were only eaten by children and 1% of households only by men.

20. In 92% of households (n=272) chickens were sold, with 44% of households selling birds only once or twice a year. In contrast, only 7% (n=20) of households purchased live birds to be incorporated into the flocks. Home-produced eggs were seldom sold (n=3). Where eggs were sold prices ranged from 35- 40 Kyat per egg. A total of 16% of households (n=47) purchased eggs for consumption.

21. Of the 272 cases specifying sale destination of chickens, a total of 53% of households (n=144) sold birds directly at the markets, about 47% of households

(n=127) sold birds to middle men and less than 1% to neighbours (n=1). Within the 20 households purchasing live chickens, 55% (n=11) bought chickens from local markets, 25% (n=5) from neighbours, and 10% (n=2) from either relatives or middle men.

22. The average number of birds sold per household was 9 birds (SD=6) per year. A total of 37% of farmers (n=109) sold roosters, 44% (n=131) sold hens, 83% (n=246) sold male growers, 71% (n=211) sold female growers and only 10% (n=29) sold chicks within the last year.

23. There were two periods per year when lower prices for the sale of chickens occurred: 1. March-May: The main reason specified for low prices was the 'hot weather' and/or the 'occurrence of disease' among birds (n=157). 2. May-July: The main reason specified was 'flooding and the presence of plenty of fish' (n=65). Another reason specified was 'chicken diseases during flooding' (n=20).

24. There was only one main period per year when high sale prices occurred. In October and November the majority of farmers considered the occurrence of ceremonies or festivals as the reason for high prices (n=222). Only a small proportion (n=7) mentioned that high prices were common during April (ceremony), when the Buddhist New Year or the water festival is held.

25. Chickens or eggs were never barter-traded in or out of households in any of the farms surveyed.

Constraints to village chicken farming in Myanmar[9]

1. A total of 92% (n=273) of farmers reported respiratory problems in their flocks. About 60% of respiratory signs were observed in chicks, 30% in growers and 10% in adults. The most frequent respiratory sign observed in chicks was nasal discharge, while growers showed primarily heavy breathing.
2. Intestinal problems were indicated by 72% (n=212) of farmers among their birds. A majority of chicks showed whitish diarrhoea, while diarrhoea was often greenish in growers and adults.
3. Only 66% of farms (n=195) reported nervous signs among their birds, with the predominant sign observed being twisting of the neck, in particular in chicks.
4. General problems as a combination of different clinical signs were observed frequently among mature birds, with the dominating age group with any of these signs being the group of growers. Ruffled feathers were the most frequently observed general sign in all age groups. Sudden death was the most common sign in adults, but also discolouration of the comb was observed frequently in growers and adults. The main other problems described were sores on eyes and head and pox marks. The most frequent other problem observed in adults was the occurrence of ectoparasites.
5. Newcastle disease and Fowl pox were the best known chicken diseases among farmers, followed by general descriptions of disease like 'diarrhoea' and 'sickness'.
6. About 24% of chicks died within the first two months of age; the estimated mortality for growers was about 19% and for adults 5%.
7. Disease as a cause of mortality became more prominent with age of the birds, while predation was a major cause of mortality in younger birds. Exposure to environmental conditions seemed to be a major cause of deaths in chicks, while theft increased with the age of the birds. The most important predators killing chickens were ranked as follows: birds of prey (32%), rats (31%), snakes (17%), dogs (15%), cats (3%) and others (2%).
8. Of 294 valid responses 11% (n=31) reported Newcastle disease outbreaks in their own flocks over the previous 12 months, 48% (n=142) reported no outbreaks and 41% of farmers (n=121) were not sure if Newcastle disease was present in their flocks in the

past. A total of 83% of farmers indicated that outbreaks occur only once a year, while the remaining proportion of farmers indicated Newcastle disease outbreaks two or more times per year. Most outbreaks occurred from March to May as indicated by 76% of farmers, with the predominant outbreak month being the month of March. Total chicken mortality during Newcastle disease outbreaks was estimated from 30 households with reported outbreaks (one farm could not recall the number of birds dying) to be 68% (95% CI 57-79%). During an outbreak, sick or infected birds were sold and/or consumed by 40% (n=12) of these 30 households. The most common sign observed during outbreaks was sudden death. Other common signs described were depression and twisting of the neck. A total of 5% of farmers (n=15) tried to treat their chickens during Newcastle disease outbreaks, with two farms using Paracetamol® and 33% (n=5) using Turmeric powder as a treatment. Other local remedies used were juice of lemon grass (n=2) and alcohol (n=1).

9. A total of only 5.4% (n=16) of all 296 farms visited in the study region conducted vaccinations against Newcastle disease within the previous year. These included 8 farms with reported Newcastle disease outbreaks. Vaccine was supplied by the local veterinarian free of charge (n=5) or for a purchase price of one (n=3) or two (n=8) Kyat. A total of 14 farms used I-2 vaccine, while the two other farms did not know which vaccine was applied. All vaccinations were conducted by eye drop. On 10 farms vaccine was applied every 3 months, on two farms every six months and on four farms only once per year. A total of 4 farms reported no losses following vaccination, 8 farms indicated reduced losses following vaccination compared to previous Newcastle disease outbreaks, one farm indicated increased losses following vaccination (one farm could not recall if losses or no losses occurred following vaccination) within the previous year.

10. The most important constraints specified by the 296 farmers were the occurrence of chicken diseases (n=144, 49%), followed by exposure of chickens to extreme weather conditions (n=15, 5%) and occurrence of predators (n=11, 4%). The most important areas to assist farmers in improving village chicken health were indicated to be vaccinations (n=109, 37%), the supply of new breeds (n=46, 16%) and extension work (n=32, 11%).

Longitudinal study to estimate Newcastle disease prevalence and to describe mortality rates among birds over time[10]

1. Across all birds, the prevalence of protective titres against Newcastle disease virus was 79% (95% confidence interval 74, 84); higher prevalences of protective titres were associated with reduced mortality rates in the following months. The monthly proportion of birds with protective titres varied considerably between villages. The observed mortality rates was higher in villages that had low proportions of birds with protective serological titres in the previous month - mortality rates decrease by a factor of 0.88 (95% confidence interval 0.78–0.99) for every 10% increase in prevalence of titres in the previous month.

2. Mortality of village chickens was often under-reported by farmers. Incidence rates based only on observed mortalities did underestimate actual incidence rates, particularly amongst chicks. The intense data collection in our study allowed estimation of numbers of unobserved mortalities and incidence rates of mortality could be adjusted accordingly. Depending on month and age group of chicken, from 71 to 231 (out of 290–307) households had discrepancies in the counts of birds. For chicks, at least one-quarter of the households had unobserved losses of at least 5 chicks per household (maximum 66 chicks); unobserved losses were less for growers and adult chickens. The median month-specific, village-specific mortality rates per 1000 bird-days at risk (counting missing birds as deaths) ranged from 0.8 to 1.7 for adults, from 0.4 to 4.7 for growers and from 8.0 to 16.5 for chicks. The frequency of unobserved mortalities amongst chicks was higher, as chicks were present in largest numbers,

chicks are not easily visible under scavenging conditions and they have the lowest financial value.

Interventions to address constraints to village chicken production

1. The capacity to rear chicks was improved by a 12-month intervention study that was designed to address these major constraints. Analysis of data collected from the study showed that improved chick rearing led to a significant reduction in chick mortality during the first 6 weeks of age. There was a significant increase in number of birds sold after a period of 6 months in the study groups with management changes, resulting in a significantly larger income for these farmers. The number of households consuming home-produced chicken meat also increased after a 6-month lag period in these groups. Mortality due to disease was reduced in groups of farmers using Newcastle disease vaccination but this was offset by deaths due to other causes.
2. Crude incidence rate of mortality: The crude incidence rate of mortality was 2.2 (standard deviation 6.1) deaths per 900 bird-days at risk. Incidence rates of mortality were highest among chicks. Higher incidence rates of mortality were observed in the months of August-September 2004 and February-April 2005 in all treatment groups. Crude mortality incidence did not differ significantly between treatments.
3. Proportional mortality rate: The proportion of deaths attributed to infectious disease rather then predation, exposure to extreme weather conditions, theft, other deaths or unknown deaths appeared lower for growers and adults in I-2 vaccinated households relative to both placebo-vaccinated households and households with management changes.
4. Newcastle disease vaccination and incidence of mortality due to ND: 60-95% of birds in I-2 vaccinated households had protective haemagglutination inhibition (HI) antibody titres (i.e. greater than 2^3). Outside periods of Newcastle disease outbreaks, protective HI titres were observed in 17-50% of birds in placebo-vaccinated households. Vaccination against Newcastle disease reduced the proportion of mortalities assumed to be caused by infectious disease in growers and adults, but crude mortality incidence did not differ between treatments suggesting that other causes of mortality outweighed any beneficial effects of vaccination on mortality due to ND in the study population. In addition only low incidences of Newcastle disease were observed during the study period, with only 17 presumed ND outbreaks over a total monitoring period of 1918 household-months. All presumed ND outbreaks occurred in March/April and were clustered within a few villages. Incidence of ND and mortality rates can vary substantially between periods as reported previously in village chickens in Myanmar[7]and in other countries[11,12,13].
5. Sale of birds: The number of birds sold did not differ between treatment groups over the entire study period. However, from February 2005, an increase in the number of birds sold was observed in households with improved chick management relative to I-2 vaccinated households.
6. Sale income: Treatment did not influence the value per bird sold. However, the total amount of income obtained from the sale of birds in household that sold birds was higher for households where management changes were applied (about 2150 Kyat per month) relative to I-2 vaccinated households.
7. Consumption of chicken meat: Over the whole study period, treatment had no effect on the number of households consuming home-produced chicken meat. However, from February 2005, more households with improved chick management changes consumed home-produced chicken meat relative to I-2 vaccinated households. No differences were observed between treatments in the amount of chicken meat consumed in those households that ate chicken meat.

8. The timing of the national I-2 vaccine production was re-scheduled to allow February vaccination (not March) against Newcastle disease. This reflects the main Newcastle disease epidemic period that was identified in the epidemiological studies as being March and April.

Extension methodologies and epidemiology training

1. Extension materials were developed (pamphlets, flip charts, booklets, posters, calendars) and farmers meetings were held to increase farmers' awareness of the economic merit of introducing chick management changes and Newcastle disease vaccination. Changes were made to extension materials and approaches modified if necessary to ensure the most effective delivery of our extension messages. This is an on-going process and involves village chicken farmers and an extension specialist, who monitored the response of farmers to the extension message.
2. Training in veterinary epidemiology was conducted using datasets obtained in the project to allow a better understanding of epidemiological methods under local conditions in Myanmar. Furthermore the diagnostic skills of Myanmar veterinary staff were improved through training courses in pathology and molecular biology. In addition the production of high quality I-2 Newcastle disease vaccine was enhanced through a workshop on vaccine production and quality control.
3. The development of new extension services on village chicken health in Myanmar was initiated. Key village people and field veterinarians were trained to conduct village chicken extension work and to supply equipment for management changes after the project is finished.

- In this context the responsibilities of the field veterinarian are:
  - Prepare a list of all village chicken households and supply this information to LBVD and the key person
  - Conduct I-2 vaccination in 3-monthly intervals
  - Support farmers on village chicken health issues
  - Work closely together with key person and supervise his work
  - Conduct training on village chicken health
  - Record the number of households using chick management equipment and I-2 vaccination before start of extension work (with key person)
  - Record the success and uptake of our suggested intervention strategies in the village and chicken diseases every month
- In this context the responsibilities of the key village person are:
  - Be the key person to respond any village chicken issues (disease, etc.)
  - Knowledge about chicken population in the village
  - Support farmers on village chicken issues
  - Supply equipment to village chicken farmers
  - Work closely together with village veterinarian
  - Conduct training on village chicken health
  - Record the number of households using chick management equipment and I-2 vaccination before start of extension work (with veterinarian)
  - Record the success and uptake of our suggested intervention strategies in the village and chicken diseases every month

4. The extension work was expanded. The total number of households in the villages involved in the extension work was 9,157 of which 3,526 households (39%) own village chickens, totalling about 55,600 birds. A total of 47 villages in three division was covered by the extension work:

Division	Township	N of Villages	N of veterinarians	N of village key persons
Yangon	Teik Gyi	14	3	14
Yangon	Than Lyin	12	5	12
Yangon	Kyauk Tan	6	2	6
Bago	Shwe Kyin	10	2	10
Mandalay	Nyaung Oo	5	2	5
TOTAL		47	14	47

5. A large number of management equipment was sold at subsidized prices to the village chicken farming community.

Equipment for improved chick management sold to farmers between June and September 2007 in Myanmar.

Division	Township	Complete sets (1 coop, 1 creep feeder, 1 bag of chick starter feed)	Bags of chick starter feed
Yangon	Teik Gyi	370	253
Yangon	Than Lyin	552	20
Yangon	Kyauk Tan	293	20
Bago	Shwe Kyin	380	
Mandalay	Nyaung Oo	155	
TOTAL		1750	293

6. Field veterinarians, key village people and LBVD staff conducted a large number of workshops on village chicken health.

Overview on workshops conducted on village chicken health from June to September 2007 in Myanmar.

Period	N workshops conducted	Total N trainees	Males	Females
Jun-07	32	677	531	146
Jul-07	41	883	715	168
Aug-07	47	1239	990	249
Sep-07	46	1170	920	250
TOTAL	166	3969	3156	813

Newcastle disease vaccine production

1. I-2 Newcastle disease vaccine production was expanded during the project period is now produced in several regional centres in Myanmar (initially I-2 vaccine was only produced in the central laboratories in Yangon and in Mandalay). Staff in each of these centres was trained in I-2 vaccine production and quality control in a project-funded workshop.

The I-2 Newcastle vaccine is now produced in five centres in Myanmar:

- Yangon (Yangon Division-Central Veterinary Lab)
- Taunggyi (Shan State)
- Pathein (Ayawady Division)
- Pyin Oo Lwin (Mandalay Division)

- Magway (Magway Division)

New proposed centres for I-2 vaccine production in development (partly functioning at the end of the project period) are in:

- Myi Kyina (Kachin State)
- Sitway (Rakhine State)
- Musae (Shan North)
- Kyinetone (Shan East)
- Nyanng Oo (Mandalay Division)
- Phaan (Kayin State)

2. Equipment and reagents supplied by the project to vaccine production laboratories have enabled the more efficient production of I-2 vaccine

Characterisation of Myanmar isolates of Newcastle disease

1. Isolates of Newcastle disease virus were successfully cultured from chickens suspected of dying from Newcastle disease. The molecular techniques that had been introduced by the project were used to amplify and sequence fragments from NDV genes.
2. Good quality sequence data were obtained from six sequence reaction products that had been sent from Myanmar to the University of Queensland. These were derived from samples of brain or internal organs from birds in three townships (see sample details in table below).

Isolate number	Date of sample receipt	Owner	Township, Village	Bird details	Sample
MT5/6	21/11/03	Hta Pa Ya	Bago, Intakaw	Breed: local Age: 1 mth	Brain
MT15/16	31/1/04	U Thein Htike	Bago	Breed: mixed Age: 7 wk	Internal organs
MT34	n.a.	U Aung Kyi	Thanlyin, Sit Pin Quin	Breed: local (Sit ta gaung)	Brain
MT38	n.a.	U Aung Kyi	Thanlyin, Sit Pin Quin	Breed: Local	Internal organs
MT41/42	n.a.	n.a.	Kyauk Tan, Kya Kan	Breed: Local	Brain

3. The phylogenetic analysis of sequence from four of the Myanmar isolates of NDV indicated that they clustered with other genotype VII isolates (see Appendix 2), which are common in China and other countries in the region. However, the Myanmar isolates formed a distinct cluster within this genotype. The remaining isolate (MT15/16) clustered with vaccine strains in genotype I, suggesting that a vaccine virus had been amplified from this bird.
4. Four of the five Myanmar isolates had the characteristic amino acid sequence of velogenic Newcastle disease viruses at the cleavage site of the F gene, while one isolate (MT15/16) had the sequence characteristic of lentogenic viruses, confirming its likely identity as a vaccine virus:

Amino acid sequence of the cleavage site of F protein

Cleavage site

MT5/6, MT34, MT38, MT41/42: 113 R-Q-K-R-↓-F 117

MT15/16: K-Q-G-R-↓-L

5. Only two of the Myanmar isolates had useable sequence from the HN gene. Of these, one (MT5/6) had a 7 amino acid extension, which is characteristic of virulent strains of virus, and one (MT15/16) had an 11 amino acid extension, which is seen in less virulent viruses.

Amino acid sequence of the HN extension

Stop codon
↓

MT5/6: KDDGV-REARSSR

MT15/16: KDDGV-REAKSSRLSQL

6. In summary, the findings from this component of the project indicate that virulent (velogenic) Newcastle disease viruses circulate amongst village chicken flocks in Myanmar. Perhaps not surprisingly, these viruses group with genotype VII viruses which are prevalent in neighbouring China and have been the cause of recent epidemics of Newcastle disease in that country[14,15]. However, the Myanmar viruses form a distinct cluster within genotype VII, suggesting that there has been genetic drift in this country allowing a small clade of Myanmar-specific viruses to evolve.

Diagnosis of poultry diseases in Myanmar

1. Through the training of staff in the LBVD diagnostic laboratories in pathology and molecular techniques, the project improved the capacity of these staff to diagnose poultry diseases.
2. In particular, the introduction of molecular diagnostic approaches during the project allowed the rapid diagnosis of H5N1 avian influenza by PCR when it first entered the country. It also allowed staff to readily participate in regional programs and workshops on HPAI diagnosis, which would not have been possible without the background in molecular techniques provided by the project.

7.2 Discussion

Overall, the project demonstrated the importance of village chicken production to the rural poor of Myanmar and the potential of this production system to enhance the livelihoods and nutrition of small-holder farmers and their families. Ranked by farmers as second only to crop production, chicken raising provides a substantial contribution to the income and diet of rural poor in Myanmar. The project demonstrated that with relatively minor interventions, the productivity of this production system can be significantly increased.

The project focused on an identify-and-response approach. The achievements of previous stages of the project directly influenced the direction of the subsequent phase.

A number of important lessons were learnt through the progression of the project:

1. A project has to be of sufficient duration to evaluate the current conditions and to enable a sustainable response.

- For example, there was a lag period of about 7 months from the introduction of management changes until the effect of these changes on chicken sales was recorded, because the extra chicks surviving were not sold until they were aged 6-7 months. If the duration of study had been shorter, this effect would have been missed.
- Seasonality of animal health events have to be considered, in both observational and experimental field studies. The impact of season can vary between months (e.g. Newcastle disease occurs mainly in the hot season in Myanmar) or even years (e.g. the challenge by Newcastle disease field virus was low during the period of our intervention study, but was reportedly higher in other years).

2. The involvement of farmers in the research approach is essential and should be encouraged.

- In all studies farmers received incentives (soap, metal plates, 'longis') at the commencement of the study and regular contact was made with the farmers throughout the study period.
- During the course of the intervention study, untreated birds in control groups were at high risk of mortality, but were essential to assess the effect of treatments applied. Farmers were compensated for any birds dying during the study. Therefore we were able to address both ethical concerns and the need for scientific validity of the study.
- Farmers were more convinced about the chick management recommendations when they observed their impact and success in their own flocks or their neighbouring flocks. For that reason farmers with positive experiences could be used to encourage other farmers' involvement in adopting new or modified approaches.

3. Extension materials used should represent the farmers most preferred aids and should relate to cultural traditions and economical resources of farmers.

- Visual aids as a means of training were the preferred method for farmers' education in Myanmar. Caricatures used in the extension materials were evaluated during farmer meetings and modified accordingly.
- Other means that can be used to promote information in Myanmar could be marionette plays. In contrast radio programs, widely used in Africa to inform about village chicken production[16], might be impracticable, as this media is not available or not widely used by local communities in Myanmar.

4. The training of local staff during the course of a project had a considerable capacity building function and complemented the sustainability approach of the project. Training represents an important component of any international aid project although it might be difficult to evaluate as a direct outcome of the project.

- Myanmar veterinarians were trained in
  - Diagnostic methods: The use of polymerase chain reaction (PCR) for the diagnosis of Newcastle disease was introduced in 2004, and was then immediately available as molecular technique for the confirmation of highly pathogenic avian influenza (H5N1) outbreaks in April 2006.
  - Veterinary epidemiology: This training enabled Myanmar veterinarians to conduct their own investigations into animal health problems using scientific approaches and assisted in the development of surveillance methodologies for a variety of animal diseases.

- Newcastle disease vaccine production: Participants developed skills that can be applied to production of high quality vaccines of other types.

8 Impacts

8.1 Scientific impacts – now and in 5 years

- This is the first survey conducted describing village chicken population structure and productivity in Myanmar. No scientific information existed prior to this study on village chicken production in the country. The project has provided veterinarians in Myanmar important baseline information that can be utilised to apply appropriate methods and treatments to improve village chicken production and health.

The impact of vaccination and management changes was evaluated for the first time using double blinded approach. In these trials, untreated birds in control groups were at high risk of mortality, but these groups were essential to assess the effect of treatments applied. All farmers were informed before the initiation of the trials that compensation would be paid for birds dying during the study. Farmers also received incentives (soap and metal plates) at the commencement of the study and regular contact was made with the farmers throughout the study period. This unique approach was effective in addressing both ethical concerns and the need for scientific validity of the study. The approaches applied can be used as examples and guidelines for other scientific and ethically appropriate field studies in the future.

Incidence rates of mortality are rarely reported for village chicken populations because data from repeated visits, including precise numbers of withdrawals and additions, are seldom collected in rural villages. Because chickens scavenge and move without restriction within villages, it is also likely that some deaths are not observed by farmers, particularly at times of the year when other agricultural activities are of greater importance than chicken keeping. However, these discrepancies between reported and unobserved mortalities have never been quantified. We developed a method to estimate the number of unobserved mortalities among village chickens and to adjust the incidence rates of mortality accordingly. This method has been accepted for publication in an international journal (*Preventive Veterinary Medicine*) and will be very useful for other research projects working with village chickens.

Extension services for village chickens did not exist in Myanmar prior to this project. We developed methods to translate scientific research findings (tables, graphs, numbers) in some understandable manner to farmer using cartoons and pictures. This is an excellent example how scientific research can reach the community.

Our project was the only international animal health project in Myanmar at the time. We were approached by the International Livestock Research Institute (ILRI) based on our experience and knowledge of the local situation to set up a co-joint research project. A collaborative research project was established with ILRI and the genetic characteristics of village chickens breeds in Myanmar were investigated in a field study. This is the first time that this information was revealed in this country.

Results of the intervention study were presented at an international epidemiology conference in August 2006. The scientific impact of our project was demonstrated when an invitation was received to present the outcomes and lessons from our smallholder poultry health project in Myanmar as invited speech at the 8th Asian Pacific Poultry Conference in Bangkok in March 2007.

The introduction of molecular techniques to the LBVD laboratories had a significant impact on their diagnostic capabilities and allowed these laboratories to perform molecular diagnosis of H5N1 avian influenza infections when the epidemic commenced in Myanmar. Without the introduction of these techniques, the LBVD staff would not have been able to conduct PCR testing for H5N1 virus.

The project has provided the first genetic analysis of Myanmar isolates of Newcastle disease virus. This work can provide the basis for further investigations of the molecular epidemiology of this virus in Myanmar, which may assist in determining the source of the country's epidemics and approaches to control of the disease.

Based on the results of our studies, recommendations were given to adjust the timing of thermostable I-2 Newcastle disease vaccination in the field in accordance to the observed ND outbreaks. For that reason the ND-I2 vaccine production has been re-scheduled to provide timely vaccine doses for this modified vaccination program.

8.2 Capacity impacts – now and in 5 years

Prior to the initial project, there was no objective information on village chicken production systems and major causes of chicken mortality in Myanmar, or on the genetic nature of Newcastle disease viruses in the country. The project has generated objective data on both the production and health of village chickens in Myanmar, and on the genotypes of Newcastle disease virus that are circulating in the region. Many capacity building impacts have occurred from the initial project, with local veterinary staff gaining experience and knowledge in pathology, molecular diagnostic methodologies, database management, vaccine production and quality control, and basic epidemiological approaches. Capacity building continued in these extensions to the project, with the training focusing on more advanced epidemiological techniques and on broader areas of project planning, extension skills and disease awareness.

The project's impact in improving the knowledge and skills of Myanmar veterinarians, and extension workers was outstanding. As a result of political influences, the veterinary profession in Myanmar had been relatively isolated from the international community for many years. This project played a significant role in bridging that isolation by providing training in a variety of different areas of veterinary science:

- survey design and the collection of epidemiological data
- diagnosis of poultry diseases
- database management and the storage of epidemiological data
- the molecular diagnosis of Newcastle Disease and other agents
- serological diagnosis of Avian Influenza virus (H5N1)
- vaccine production and quality control of vaccines
- veterinary epidemiology and outbreak investigations
- extension methodology
- data analysis using spreadsheets.

All of these activities did not only relate to project specific project activities, but improved new knowledge and skills in areas outside the scope of the project. For example, epidemiology training with village chicken to obtain skills that can be applied to other epidemiological investigations; PCR methods can be applied to for the detection of other viruses than ND; extension training will help to develop new extension strategies not only for village poultry but for other animal species. LBVD staff is now enabled to conduct their

own investigations based on the experiences gained in the project (e.g. currently I-2 vaccination response titres are monitored in the field).

A large number of equipment was provided. No PCR machine existed in LBVD before the commencement of the project. This machine is now used for a variety of diagnostic approaches. Refrigerators were introduced, new equipment to enhance the production of quality vaccines, computers for epidemiological work and presentations. We were also able to import a car for the project's field work. It is usually very difficult to purchase new cars in Myanmar. The project vehicle is now used as the main vehicle during outbreak investigations.

8.3 Community impacts – now and in 5 years

Our project resulted in specific changes in social, economic, or environmental conditions due to the uptake of information or technology by groups not directly involved or collaborating on the project. Several NGOs working in the country now promote our research findings. For example, NGO AgroAction advocate uptake of our findings on chick management changes and I-2 vaccination, NGO Care Myanmar sponsor HPAI public awareness and information on bio-security based on our extension materials, and FAO also utilise the project's extension materials for HPAI education. Furthermore new NGO projects base their work directly on our project outline and success. For example, NGO Winrock International is investigating socio-economic factors influencing prevention and control of Avian Influenza with respect to village poultry farming.

8.3.1 Economic impacts

The economic impact of our project was always the major driving point. We measured farmers' direct profit during the course of the study instead of predictive modelling of possible impacts.

Improved chick management resulted in more chicks surviving, resulting in additional 2150 Kyat (~US $2) to the household. This beneficial effect was noticeable after a lag period of 7 months (as sale and consumption of growers are usually at 6-7 months of age).

As more chicks are surviving, more birds can be sold. This results in more birds being available at the markets. By increasing the number of village poultry sold in local markets, a better supply of this important food source could be achieved.

Management equipment was sold initially at subsidized prices. Farmers are now convinced about their success and are happy to pay full prices for them as the cost will amortised from the larger sale of birds within 7 months.

Because of the higher demand by farmers, chick management equipment is now locally produced by weavers especially employed for this task (at the beginning of the study bamboo coops and creep feeders were produced by one weaver far away and had to be transported to the study villages).

Local feed mills are interested in the high demand for chick starter feed and offer to produce locally (at present CP chick starter feed is purchased, repacked and sold).

More households with improved chick management changes consumed home-produced chicken meat. Chickens for consumption are usually not purchased by farmers as farmers have no funds available to do so. This reflects the fact that the nutritional value of food consumption does increase as a result of the management changes.

A more detailed economic analysis will be published during the course of the year 2008.

8.3.2 Social impacts

The project resulted in significant social impacts. Women were targeted during farmer meetings as they are often look after village chickens. Children were also engaged and some of the extension material was especially designed for children. Community meetings were organised in schools and monasteries and houses of the village head men or key village person. The community was brought together and together village chicken health was discussed. I-2 vaccination and distribution became a community event.

Various NGOs working on H5N1 avian influenza in Myanmar requested copies of our extension materials as they provided the first available information on chicken-keeping practices in the country.

Through the increased usage of Newcastle disease vaccine and the introduction of improved methods of chick management, the numbers of village chickens in the village households will increase. This will benefit all village residents, in particular the women and children. Chicken production is often under the control of women and they often have access to any benefits. These benefits are the money obtained through sale of chickens and improved nutrition through access to high quality animal protein.

8.3.3 Environmental impacts

Our project is an excellent example how natural resources are used effectively to result in an economically viable product with no negative environmental impacts. Village chickens rely on the scavenging resources and they don't impact on soil and water quality as larger poultry enterprises do. Food scraps are converted, together with broken rice and left over rice from the rice harvest. Therefore free-range village poultry have minimal impact on the environment and can actually improve the local environment through the provision of organic fertilizer and the control of insect pests. Village chickens provide a sustainable and environment friendly solution to convert poor resources into viable items.

8.4 Communication and dissemination activities

Our project always aimed to disseminate information to a wide variety of recipients. We produced information leaflets that were distributed to a variety of NGOs and international organisations.

We published our results in international journals for the wider international community.

Our project was recognized by the Family Poultry Network of the World Poultry Science Association.

The project results were published online on the Rural Poultry Centre website.

We presented our project results to a wide range of researchers working in different areas: to the veterinary epidemiological community at ISVEE, to the pacific poultry association community and to the International Poultry Industry and WSPA.

Our results were promoted in Myanmar during presentations to students and staff at the University of Yezin and to the Myanmar Veterinary Association.

LBVD staff was always informed about current research status during each visit to the country.

Field veterinarians were informed about preliminary results during the course of the surveys.

Using a variety of extension approaches, information about the project and village chicken health and production in general was disseminated to village communities in Myanmar.

The progress and results of this project were disseminated in a number of ways, which encouraged the uptake of project outputs. The veterinary epidemiologist employed on the project worked closely with Myanmar extension veterinarians and livestock officers to facilitate broad dissemination of information regarding the health and management of village poultry, with a focus on Newcastle disease control and general village chicken health.

One component of the project is the development of improved extension materials for the dissemination of information related to Newcastle disease control and improved chick management. Recommendations were based on the results obtained in the intervention study. These materials were tailored to the target audience of small-scale chicken owners and delivered the message in the most appropriate manner to these people. The extension program was expanded by including information on Highly Pathogenic Avian Influenza, food safety, I-2 vaccination and village chicken management in an extensive extension campaign in which farmer and community meetings were used to spread the extension messages. Extension messages were evaluated by an extension specialist and modified accordingly.

Project related publications are listed in section 10.

9 Conclusions and recommendations

9.1 Conclusions

This project focused on improving food security, nutrition and income of villagers in Myanmar by addressing the major constraints to productivity of scavenging village chickens. Initially, a baseline survey confirmed the importance of chicken keeping to rural farmers in Myanmar, with chicken-keeping being ranked as their second most important wealth producing activity (behind crop production). The two baseline studies identified that mortality in young chicks and deaths from Newcastle disease were two major constraints to improving chicken production in villages. These issues were then addressed in a 12-month intervention study, which demonstrated a significant increase in the number of birds sold after a period of 6-months in the group of farmers who introduced changes to the management of young chicks. The number of households consuming home-produced chicken meat also increased in this group. Mortality due to disease was reduced in groups of farmers using Newcastle disease vaccination but other causes of mortality outweighed any beneficial effects of vaccination on mortality due to ND in the study population. These studies indicated that farmers' awareness towards village chicken mortality can be poor, which was also highlighted in the high rates of unobserved chicken mortalities observed in this project. In addition challenge through ND field virus was low during the intervention study period – this phenomena of varying incidence of ND and mortality rates between periods had been reported previously for village chickens in Myanmar[7] and in and other countries[11,12,13].

An extension program was developed during the project, including the production of extension materials based on the outcomes of the studies. A series of farmers meetings was conducted to demonstrate to farmers the production benefits of introducing chick management changes and Newcastle disease vaccination and to discuss the extension

messages. As no specific extension service on village chicken health currently exists in Myanmar the establishment of such a service was encouraged.

This project used a stepwise approach using scientific investigations involving the village chicken-owning community and a participatory development of extension material and services. This approach was able to increase the awareness of small holder poultry owners' towards village chicken health and production.

Because of the political situation in Myanmar, this project was the first major international aid project conducted on animal health in the country for some decades. As a result, the impact in terms of capacity building of veterinary staff was considerable. At the commencement of the project, staff of the LBVD had been somewhat isolated from the international veterinary community. This project helped to address that isolation, with training courses in a variety of veterinary disciplines, provision of equipment and resources and the building of strong collaborative relationships between Myanmar and Australian project staff. This capacity building proved significant in assisting Myanmar authorities to deal with the regional outbreak of H5N1 avian influenza that occurred just a couple of years after the start of the project.

Follow up projects on animal heath in Myanmar are required to improve the livelihood, income and human health of people working with livestock in this country and to continue the capacity building of veterinary staff in Myanmar. This was highlighted by international consultants working in our project. However, political considerations will probably hinder future developments in this area.

9.2 Recommendations

Village chickens are often not the priority of international development projects. Although village chickens may not provide the main source of income for rural households, they deserve consideration because they can have significant impact on the nutrition and income of rural families. Farmers' inputs on village chicken production are limited by their financial resources and most farmers in Myanmar will not be able to able to convert scavenging indigenous chickens into large- or medium-scale commercial production units. Therefore, well-conducted and thorough research and participatory village chicken studies should continue.

It would be advisable and preferable if further sponsorship of animal health projects in Myanmar would be supported by the international community. In particular Avian Influenza is remerging in the country but without further international support, research funds are not possible to be obtained in Myanmar. Based on our experience and discussions with our Myanmar colleagues, we have indicated below the research and development topics that we feel would be most beneficial for both the animal health situation in Myanmar and Australian interests in the SE-Asian region.

Veterinary extension services: In the first two years of our project primarily epidemiological studies were conducted, although extension components were already incorporated into the studies. The last project year focused entirely on extension work. However, extension work is a lengthy process as farmers' behaviours are difficult to change. In addition no extension services exist within the Livestock, Breeding and Veterinary Department (LBVD) and although training was provided further guidance of LBVD staff and field veterinarians will be necessary. We belief that more time is required to further develop the extension services and to manifest a sustainability of our project achievements. This was also the opinion of Jo Crosby, an external consultant and extension specialist, who visited our project in March 2007.

Highly Pathogenic Avian Influenza (HPAI): HPAI is now a serious predicament in Myanmar. Because our project focused on constraints to village chicken production, we incorporated awareness campaigns on HPAI early on in our extension work, even before the first HPAI outbreak occurred in Myanmar. In fact, our extension material was used by other aid agencies to promote HPAI education after the disease established itself in the country. Currently LBVD concentrates on stamping out to control the disease, but the department is worried that this approach might not be effective in the future. Imported HPAI vaccines are too expensive for Myanmar; LBVD highlighted the need for assistance to evaluate vaccine potency under Myanmar conditions. However, there is no HPAI research currently conducted in Myanmar. International organisations provide only emergency support, but no funding for HPAI research. HPAI is now frequently re-emerging and village poultry, wild birds and in particular quail are considered as possible sources of infection. Without international support for research, the chance to understand and control the current epidemiological situation of HPAI in Myanmar will be missed.

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11 Appendixes

11.1 Appendix 1: Methodology in Objective 8

Workshop on extension methodology

The idea of the workshop was to train LBVD staff from different parts of Myanmar in the delivery of extension messages. No extension services exist within LBVD and this workshop should serve as a potential seed for the development of such a service focusing on animal health issues in Myanmar. Considerable efforts were made to select participants throughout Myanmar and representatives from LBVD from seven states and divisions were invited.

The workshop was conducted over two days in a training centre at LBVD in Yangon. A back-up generator and batteries were hired to provide constant power supply during the workshop.

A series of lectures and practical exercises was used. It was decided that the extension messages to be developed in the workshop should focus on 'practice change'; a solely public awareness program would not be sufficient. Therefore the workshop was conducted interactively and specific goals for the improvement of village chicken health were set-up and methods for the fulfilment were developed. The participants were divided into three groups and each group developed their own specific goals and action plans on topics relating to village chicken health:

- To obtain 80% Newcastle disease vaccination coverage in the Bago district during a period between March to May 2007
- To reduce the mortality of village chicks younger than 6 weeks of age to 10-15% for 80% of households in the Sit Pin Kwin village within three years
- To increase the awareness of Avian Influenza in 1000 people in the Hlegu township (Yangon division) during the months of October and November 2007.

The workshop can be considered as an introduction of LBVD staff to techniques for extension planning. Further training of LBVD staff in project planning and evaluation would be necessary to develop a broad base of extension knowledge within LBVD. LBVD has currently no poultry extension service. Veterinary field staff is primarily concerned with prevention and control of large livestock diseases at the village level. The extension specialist recommended that further funding should be sought to conduct the extension work over a period of at least two years (until 2009). This period would allow for further training of field staff, farmer engagement, and the development and implementation of an evaluation plan.

Structure of extension services

No extension services existed within LBVD before the start of this project. Therefore a hierarchical model was developed with responsibilities for supervision, training and support from the department level down to the farmer level with a focus on village chicken health. Incentives and honorarium were paid to people involved in the extension work. Farmer workshops were used to disseminate and exchange information. The following main areas became the focus of the extension work:

- I-2 vaccination
  - Conducted through field veterinarian
  - Conducted in: February, May, August, November

  - Vaccine is supplied through LBVD
  - Cost of vaccination: 0.2 Kyat per bird.
- Management improvement for the raising of chicks
  - Sale of sets consisting of
    - One coop
    - One creep feeder
    - One package of starter feed (1kg)
    - One booklet on village chicken health
  - Sets should be supplied every month to the key person over the next 6 months (number of sets provided depends on the number of chicken-owning households)
  - One set was initially sold for 600 Kyat to the farmer (1400 Kyat purchase price is initially subsidized through the ACIAR project)
    - Key person receives 100 Kyat of each set sold
    - Veterinarian receives 100 Kyat of each set sold
    - 400 Kyat of each set sold are returned to the township veterinary office/LBVD
  - After 6 months full price has to be paid by the farmer

Baseline information on the use of I-2 vaccination and the use of equipment for managing young chicks were collected before the start of the extension program. The uptake of extension messages was measured monthly. Forms to record this information were provided. The focus of the extension work was expanded from the Yangon Division to other states and divisions.

Each township veterinary officer was made responsible for the preparation of a list of 15 villages selected in the Taik Kyi township and 15 villages selected in Than Hlin/KyauThan townships that will be involved in the extension work. Information on the total number of households in the selected villages, the number of household with village chickens and the total village chicken population had to be compiled. Selected villages for extension work should have had a large village chicken population and should have been accessible with not too many difficulties. A field veterinarian and a key village chicken person were selected for each village.

The responsibilities of the field veterinarian were the following:

- To prepare a list of all village chicken households (together with the key village person) and to supply this information to LBVD
- To conduct I-2 vaccination in 3-monthly intervals
- To support farmers on village chicken health issues
- To work closely together with the key person and to supervise the key person’s work
- To conduct training on village chicken health
- To record the number of households using chick management equipment and I-2 vaccination before the start of extension work (together with the key person)
- To record the success and uptake of our suggested intervention strategies in the village and to record the occurrence of chicken health problems every month

The benefits for the field veterinarian were the following:

- He/she will be actively supported and involved in the ACIAR project
- He/she will receive 100 Kyat per set sold
- He/she will receive 6,000 Kyat per month for his work
- He/she will receive 10,000 Kyat per training conducted (5,000 Kyat as honorarium and 5,000 Kyat to cover the cost of the training)

The responsibilities of the key village person were the following:

- To be the key person responding to any village chicken issues (disease occurrence, request for vaccination etc.)
- To know the village chicken population in the village
- To support farmers on all village chicken issues
- To supply equipment to village chicken farmers
- To work closely together with village veterinarian
- To conduct training on village chicken health together with field veterinarian
- To record the number of households using chick management equipment and I-2 vaccination before start of extension work (together with veterinarian)
- To record the success and uptake of our suggested intervention strategies in the village and chicken diseases every month

The benefits for the key village person were the following:

- He/she will be actively supported and involved in the ACIAR project
- He/she will receive 100 Kyat per set sold
- He/she will receive 4,000 Kyat per month for his work
- He/she will receive 4,000 Kyat per training conducted

LBVD conducted training workshops with field veterinarians and key village people in all selected villages. During these workshops LBVD staff conducted the following tasks:

- Explain the purpose of the extension work, the tasks to be conducted and business arrangements (use JH's presentation as guideline)
- Explain extension message using flip charts, equipment (coops, creep feeders, starter feed) and pamphlets
- Explain baseline form for the collection of information before the start of the extension work
  - To be completed by field veterinarian/key person
  - One copy kept by field veterinarians, one copy to be sent to LBVD
- Explain monthly follow-up form to record information on the uptake of extension messages and the occurrence of poultry health problems
  - To be completed by field veterinarian/key person
  - One copy kept by field veterinarians, one copy to be send to LBVD
- Set up bi-monthly training schedules for every village

- Forms recording participants and questions/problems raised have to be completed at each training session and has to be returned to LBVD
- The guidelines for training sessions should be explained
- LBVD representatives should be present during training sessions to supervise activities and to respond to questions raised LBVD provided sets of management equipment to the key persons/field veterinarians.
- The number of equipment to be produced should be calculated to allow that 70-80% of all village chicken-owning households in each village are supplied with one set.
- The supply/transport of the equipment to the selected villages should be organized.

LBVD provided monthly feed-back on extension work to JH per email.

LBVD re-scheduled vaccine production to allow February vaccination (not March) against Newcastle disease.

Guidelines for farmer workshops on village chicken health

The training workshop will be conducted by the field veterinarian and the key person of the selected village. Representatives from LBVD will be present to supervise the training and to respond to questions. Village chicken farmers, other field veterinarians, the village head men, traders of animal feed, shop owners and other village officials will be invited. Presentation and group discussions on village chicken health will be conducted. Flip charts will be used at every training session. During this meetings equipment for management improvement should be made available to farmers. I-2 vaccination should be promoted. Flyers and booklets on village chicken health will be handed out. Farmers should be able to buy the equipment after the meeting. A lottery can be conducted to distribute some of the equipment.

Flip charts were the main tool for delivering the extension messages. The following information is presented sequentially:

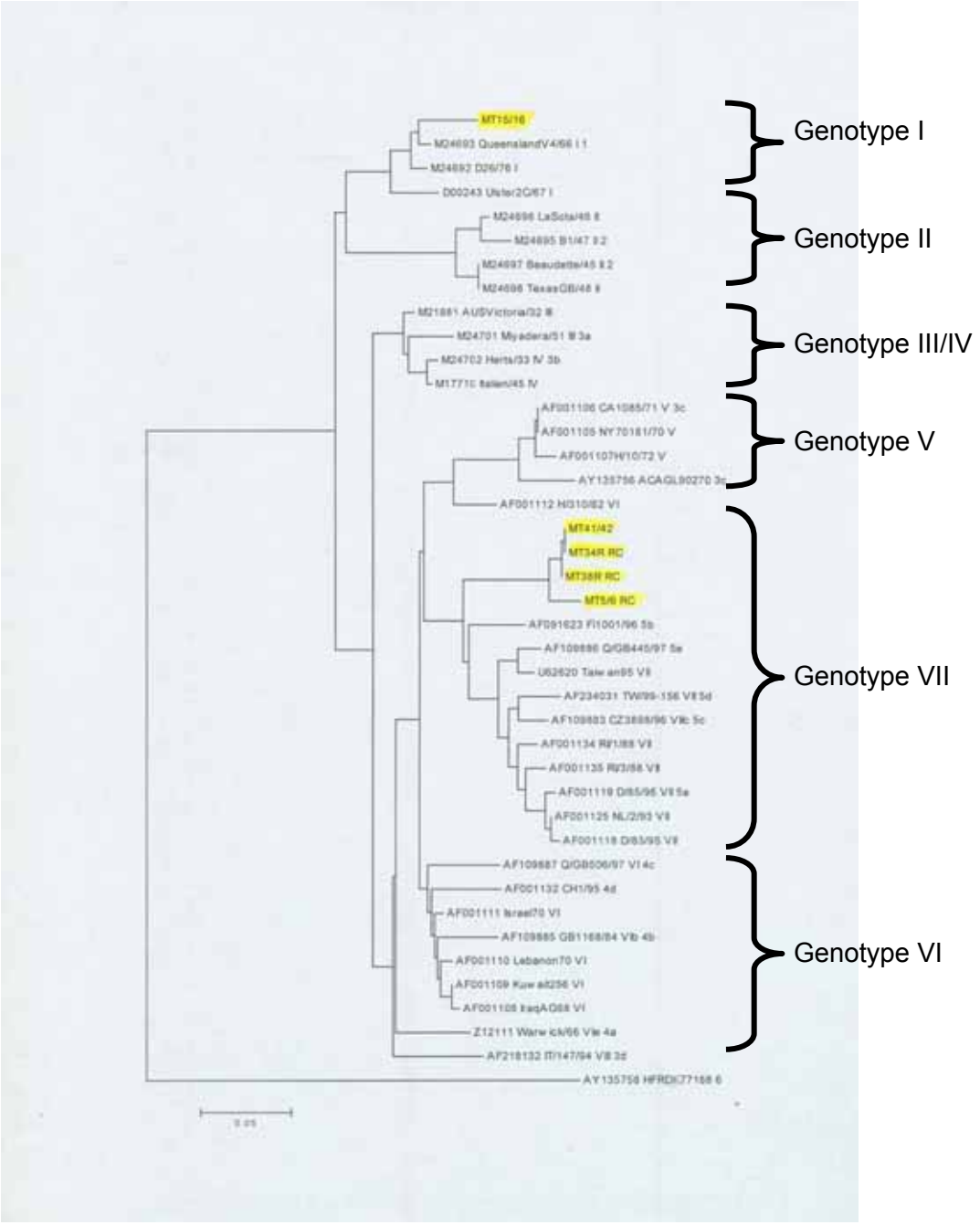
- The potential to increase the farmers' disposable income from the sale of additional village chickens should be highlighted. This is a direct result from the management changes applied in the intervention study: farmers can earn more money by selling more birds that survived. It should be mentioned that if the instruction will be followed a 'normal' village chicken farmer can become a 'happier/richer' village chicken farmer.
- The main causes of chicken mortality should be described. High mortality of young chicks due exposure to extreme weather conditions and due to predation should be highlighted. The main predators should be explained.
- A greater awareness towards the seasonal occurrence of Newcastle disease should be highlighted. The symptoms of Newcastle disease (ND) and the high mortality within a flock due to ND should be explained.
- The prevention of ND by using I-2 vaccine should be described. The contrast between a healthy flock and a flock suffering from Newcastle disease should be explained using the cartoons.
- Farmers should be informed about the most appropriate months of I-2 vaccination (February, May, August, and November). The procedure of vaccination using eye drop should be explained.

- The yearly cycle of mortality should be explained. The months with higher mortality (more dead chickens displayed in the boxes representing months in the chart) should be explained – this is mainly due to the seasonal exposure to extreme weather conditions and the seasonal occurrence of Newcastle disease. It should be explained that predation is occurring throughout the year. The months of I-2 vaccination shown in the yearly cycle should be mentioned again.
- The management changes to improve the survival of birds in the age group up to 6 weeks should be explained.
  - Chick should be confined with the hen for 1 week under bamboo coops; with a creep feeder provided inside the bamboo coop. Supplementary chick feed is provided to the chicks inside the creep feeder, but not to the hen. The hen receives broken rice. The chicks can have contact with the hen as they can walk through the gaps of the creep feeder.
  - Chicks will be confined at night together with the hen in the second and third week. At day time chicks are scavenging with hen.
  - Chicks will be confined at night by themselves (not together with the hen as chicks are already to large by then) from the fourth up to the sixth weeks of age. At day time chicks are scavenging with hen.
- Bio-security measures in a village chicken environment to prevent infectious disease outbreaks should be explained. These measures include the separation of sick birds from healthy birds and the prevention of people entering properties with sick or dead poultry.
- Furthermore a mingling between chickens and wild birds should be avoided. Dead birds should not be thrown into creeks or waterways.
- The activities to be conducted when a dead chicken is found should be explained. Birds should be sealed into a plastic bag and then be placed above the ground to avoid it being scavenged. People should wash their hands after having contact with a dead bird. The field veterinarian/township veterinary officer should be informed; through them the next activities will be organized, including the collection of dead birds by veterinary authorities.
- Appropriate procedures for processing chicken products for human consumption should be described. After handling chicken meat, hands must be washed. Chicken meat has to be cooked properly.
- The presentation is concluded by showing again the pictures of the ‘happy’ and ‘not so happy’ farmer. It should be highlighted that if all the instructions given will be followed every chicken farmer can be become a happier farmer and can make more money from his/her birds.

Discussions with farmers on village chicken health were an important part of the farmer meetings. They are used to inquire if farmers have any questions regarding the presentation given. Representatives from LBVD were present to respond to questions. Questions (and answers) as well as comments were recorded. Farmers’ perceptions about major constraints to village chicken production were questioned (ND, predation, extreme weather, other diseases). Any concerns of farmers in regards to village chicken health (e.g. Avian Influenza) were recorded. Creep feeders, bamboo coops and chick starter were available for purchase during the meeting and farmers were informed about the opportunity to purchase the equipment and /or the chick starter feed from the veterinarian, village head man and village chicken key person. Information material on village chicken health were distributed to farmers (booklets on village chicken health, calendars etc.). Some of the sets (coop, creep feeder and bag of starter feed) were distributed to farmer’s trough a lottery. This was announced before the meeting to attract

more farmers participating at the meeting. It was also inquired if farmers have any other ideas or comments how the extension work on village chicken health could be improved.

11.2 Appendix 2: Phylogenetic analysis of Myanmar Newcastle disease virus isolates



Phylogenetic tree of Newcastle disease viruses based on nucleotide sequence of the F gene. The virus isolates from Myanmar sequenced in this study are highlighted in yellow.