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Improving village chicken production:

A MANUAL FOR FIELD WORKERS AND TRAINERS

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Christine Ahlers, Robyn Alders, Brigitte Bagnol,
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Foreword

Poultry have contributed to human health and wellbeing for millennia. For rural communities, poultry continue to be an integral part of farming systems and household economies. For cities and towns, where an increasing proportion of people now live, large- and small-scale commercial poultry industries play a critical role in providing safe, good-quality products for urban consumers. In many countries, commercial and household poultry are located within the same communities, and improvement programs designed to increase the capacity of producers and introduce new technologies and practices can have widespread impact.

Australia has supported the implementation of effective village chicken production programs in Asia, Africa and Latin America, including several research projects funded by the Australian Centre for International Agricultural Research (ACIAR). This investment in research and development, always in collaboration with producers, traders and other stakeholders, has been shown to increase poultry numbers, household purchasing power, home consumption of chicken products (resulting in improved nutrition for families) and the decision-making power of women. Village chicken improvement programs have the potential to contribute to each of the Millennium Development Goals and to do so for the most vulnerable families in developing countries.

This is the fourth manual on improvements to village chicken production supported by ACIAR.[1] These manuals aim to fill gaps in the training literature, which has dealt mostly with intensive commercial production or backyard production in developed countries. This manual is focused on developing countries and describes husbandry practices and biosecurity measures for village chickens that can be implemented using locally available resources. These measures will lead to both increased productivity and improved protection from disease in village chicken systems.

The manual is comprehensive, covering many aspects of production and health. It draws on the research results of a number of ACIAR-funded projects that provided a sustainable base to the control of Newcastle disease (ND) in village chickens using thermotolerant vaccine. Newcastle disease remains a major constraint to poultry production worldwide and these projects recognised that benefits to farmers can be further increased when other health and production issues are tackled in addition to vaccination.

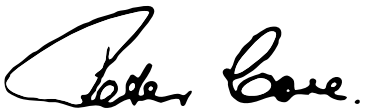
Much of the content of the manual has been developed to this final stage during a project funded by the Australian Agency for International Development (AusAID) from 2002 to 2005, to implement the Southern Africa Newcastle Disease Control Project (SANDCP) in Malawi, Mozambique and

1 Controlling Newcastle disease in village chickens: field (Alders and Spreadbrow 2001), training (Alders et al. 2002) and laboratory (Young at al. 2002) manuals (ACIAR Monographs 82, 86 and 87, respectively)

Tanzania. SANDCP followed on from 7 years of ACIAR-funded research on ND control conducted by the Mozambican National Institute for Veterinary Research and the University of Queensland.

It is pleasing to note that the success of SANDCP, including the use of the training material in this manual, has gone well beyond the control of ND in these three countries and has laid a foundation for responding effectively to the worldwide epidemic of highly pathogenic avian influenza and in developing livelihood strategies for communities affected by high levels of HIV/AIDS.

ACIAR will continue to support research that contributes to food security, food safety and ecologically sustainable livestock production, and to recognise that building capacity in poultry health and production is of special significance to developing countries.



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Special thanks go to Mr Razac Chame for his patience and artistic excellence in providing all of the illustrations for this manual.

Abbreviations

ACIAR	Australian Centre for International Agricultural Research
AIDS	acquired immune deficiency syndrome
CRD	chronic respiratory disease
°C	degrees Celsius
FAO	Food and Agriculture Organization of the United Nations
FGD	focus group discussion
g	grams
HIV	human immunodeficiency virus
HPAI	highly pathogenic avian influenza
IB	infectious bronchitis
IBD	infectious bursal disease, also known as Gumboro disease
kg	kilogram
L	litre
m	metre
m^2	square metre
mL	millilitre
ND	Newcastle disease
NGO	non-government organisation
PRA	participatory rural appraisal
OIE	World Organisation for Animal Health (Organisation Internationale des Epizooties)
PPE	personal protective equipment
SFRB	scavenging feed resource base

Glossary

Antibody	A protein produced by specialised B cells after stimulation by an antigen. Antibodies bind with antigens on foreign organisms to help inactivate them. Each antibody can bind to only one specific antigen.
Biosecurity	Any practice or system that prevents the spread of infectious agents from infected to susceptible animals, or prevents the introduction of infected animals into a herd, region, or country in which the infection has not yet occurred. More specifically, biosecurity combines 'bioexclusion', i.e. measures for preventing a pathogen from being introduced into a herd/flock, and 'biocontainment', stopping the spread of a pathogen among animal groups within a farm or of being released from the farm.
Broody	If a hen (= female chicken) is broody, she is ready to lay eggs and sit on them.
Cloaca	The internal cavity into which the intestinal, urinary and genital canals empty in birds. In females it also serves as the depository for sperm. The cloaca has an opening (vent) for expelling its contents from the body.
Cockerel	A young male chicken.
Droppings	The excrement (i.e. manure) produced by animals and birds.
Embryo	An animal that is developing, either in its mother's womb or in an egg, or a plant that is developing in a seed.
Endemic	An endemic disease or condition is one that is regularly found and very common among a particular group or in a particular area.
Fomites	Inanimate objects such as boots, clothing, equipment, instruments, vaccination needles, vehicles, crates or packaging that can transmit an infectious agent to a new host mechanically. Fomites become contaminated but not infected.
Forage	Food grown for livestock consumption.
Gleanings	Cereal remnants in the field after harvesting.
Genotype	The particular type and arrangement of genes in an organism.
I-2 vaccine	Thermotolerant, live, avirulent Newcastle disease vaccine.

Lipid	A substance such as a fat, oil or wax that dissolves in alcohol but not in water and is an important part of living cells.
Mechanical transmission	The transfer of an infection from one animal to a new host where the transmitter is not infected, in that tissues are not invaded and the agent does not multiply. Fomites are often involved in mechanical transmission.
Mutation	A sudden change from the parent type in one or more heritable characteristics, caused by a change in a gene or a chromosome.
Organic	Organic produce, such as plants and animals grown for food, is produce grown without the use of insecticides and other synthetic chemicals.
Pathognomonic	A pathognomonic sign is a specific sign whose presence means, beyond any doubt, that a particular disease is present.
Pullet	A young, female domestic fowl, especially a chicken, from the time she begins to lay until first moult.
Rales	A clicking, rattling, or crackling noise heard during inhalation.
Reassortment	The fragmentation and reassembly of the genetic material of two similar viruses that are infecting the same cell.
Rooster	An adult male chicken.
Snick	A high-pitched sound associated with sneezing in poultry.
Thermolabile	A thermolabile agent loses activity (especially infectivity) at elevated temperatures.
Thermotolerant	A thermotolerant agent retains activity (especially infectivity) at elevated temperatures.
Tropism	A preference for a particular location or direction. The site preferred by a virus (e.g. ND virus) for replication within the body.
Vent	The external opening of the cloaca, through which eggs and droppings pass.
Vertical transmission	Passage of a disease-causing agent (a pathogen) vertically from mother directly to her offspring during pregnancy or lactation. In the case of poultry, the transmission is from the hen to her chick via the egg.
Virulence	Refers to the degree of pathogenicity of a microbe or, in other words, the relative ability of a microbe to cause disease.

PART 1

Village chickens and village chicken farmers

The improvement of village chicken production can have a profound effect on the wellbeing of rural families. The effective, low-cost interventions described in this manual can directly contribute to poverty alleviation, household food security, income generation, HIV/AIDS mitigation and wildlife conservation. Working with male and female farmers to improve the production of their village chickens also provides opportunities to enhance their understanding of nutrition, stock management, and the origins and development of diseases.

- Farmers' knowledge of poultry and human nutrition can be increased in parallel. Since women are often the family members responsible for both the care of poultry and the preparation of the family's meals, this approach can bring big benefits.
- Once the production of village chickens improves, farmers take a greater interest in managing their stocks of birds by monitoring the availability of local feed resources and assessing options for the off-take of birds by sale or other means.
- Ensuring that farmers understand disease processes is an essential step as it is very difficult to improve biosecurity practices if they do not believe that diseases are caused by infectious agents.

Before promoting improved management and disease control in an area or village, it is important to understand the existing environment in which village chickens are produced. Part 1 of this manual therefore provides, in three chapters, background material on the role of village chickens and where they fit into the rural production system. It also describes how to involve the community in any activities relating to village chicken production. It should be read and understood before deciding on implementing any of the interventions described in Parts 2 and 3.

A number of terms that may be unfamiliar are defined in the glossary at the beginning of the manual.

1 Introduction

1.1 Village chickens defined

Village chickens are the most common type of livestock in many rural areas. Even very poor households with few labour resources will normally keep some chickens. 'Village' chickens are also known as rural, indigenous, scavenging, traditional or family chickens, and have various names in local languages.

There are several definitions of village, rural or family poultry. The main differences between them relate to the degree to which aspects of more intensive and commercial chicken production systems are included. For the purposes of this manual, *family poultry* is used as a more general category that also includes production systems more commonly found in urban areas, where a family raises chickens in an enclosure with a greater level of purchased inputs. The term *village poultry*, on the other hand, refers to the extensive production systems most commonly found in rural areas, and usually involves indigenous chicken genotypes. The information provided in this manual is directed toward improvements to village poultry systems and aims to maintain the basic advantages of this system, which are low inputs and, consequently, low risk. Although the emphasis is on village chickens, many of the recommendations in this manual can be applied to other poultry species, such as ducks, turkeys and guinea fowl.

Village poultry:

- comprise local genetic stock (sometimes, but rarely, interbred with improved stock)
- are raised extensively in relatively small numbers (between 1–50 at any time, although more commonly 5–15 birds)
- are not usually confined and obtain most of their diet from scavenging for food and water around the home (including household wastes) and village
- require minimal investment in inputs, with most if not all of the inputs generated around the home
- engage labour inputs that are not salaried but are drawn from the family, with women and children commonly most responsible for their care
- production is geared essentially toward home consumption and savings (a living bank) for small expenses such as school fees and medicines.

Animal protein consumed in rural areas frequently comes from village chicken meat and eggs. Chickens can also be sold or bartered to meet family needs

such as medicines, clothes and school fees. In this way, they act as a ready source of cash for emergencies and small purchases. Village chickens provide manure and play a role in pest control. They are also important for special festivals or to meet social obligations, and they are essential for many traditional ceremonies and methods of treating illnesses. They are generally owned and managed by women and children, and are often an essential part of households headed by women.

Chicken meat and eggs

Chicken meat and eggs provide a readily available, high-quality source of proteins, vitamins and micronutrients. Eggs are an excellent source of iron, zinc and vitamin A, all of which are essential to health, growth and wellbeing. Chickens and eggs contribute to a nutritious, balanced diet, which is especially important for children, nursing mothers and people who are ill.

Village chickens play a very important role in poor rural communities in that they can convert feed available around a house or village (the 'scavenging feed resource base', SFRB—see Section 2.4) into highly nutritious, well-appreciated products.

Although the output of traditional village chickens in terms of weight gain and number of eggs per hen per year is low, it is obtained with minimal labour and other inputs. This factor of low input and, consequently, low risk is one of the major advantages of village chicken production. It is important to remember that it is undesirable for any initial improvements to village chicken production to significantly raise the labour costs or financial risks involved in the activity.

Simple changes in management of village chickens can significantly improve production and the living conditions of many rural families in terms of enhanced nutrition and income generation through the sale of surplus chickens or eggs. Improved village chicken production is therefore a low-cost and important aspect of rural development.

1.2 About this manual

This manual follows on from 'Controlling Newcastle disease in village chickens: a training manual' (Alders et al. 2002). That manual and associated handbooks (see the Bibliography for a list of titles) were designed to help extension workers and community vaccinators to understand how Newcastle disease (ND) can be controlled in rural areas.

In many places, ND is considered the most significant constraint to village chicken production. Poultry farmers' familiarity with the high mortality caused

by ND has delayed the detection of highly pathogenic avian influenza (HPAI) in many countries and complicated HPAI control measures. The effective control of ND will facilitate the early detection of incursions of HPAI by reducing mortality in flocks and improving relations between farmers and animal health authorities. However, once ND is controlled, there are other diseases that will naturally assume greater importance and which traditionally have received less attention in research and extension programs. While none of these diseases is likely to be individually as significant as ND, collectively they are very important and can markedly reduce the potential benefits from ND control.

As ND control improves, producers are motivated to take the next steps in improving their chicken production. They talk about increasing flock size, controlling other diseases, reducing mortalities from predators, minimising theft, improving feeding and organising better marketing systems. Once a successful ND control program is under way, extension agencies can prepare for the increase in the demand for information by organising training and information for extension officers. Until recently, however, most of the information relating to chicken production was directed toward intensive or semi-intensive systems.

This manual aims to provide, for extension workers and livestock officers, basic information on the production of traditional village chickens and how productivity can be improved by introducing appropriate, low-cost approaches. The manual describes the initial steps that can be taken to improve village chicken production. More costly techniques, such as keeping birds permanently in chicken houses and supplying only commercial feed, are not covered in this manual, although information about these techniques can be obtained from documents posted on websites listed in the 'Sources of further information' section in Appendix 6. These other techniques could be tested by farmers after they are comfortable implementing the suggestions described in this manual and they have a good understanding of the extra costs and labour that would be required for more intensive chicken production.

Although this manual includes information on ND, the more comprehensive ND training manual mentioned earlier should be referred to for controlling this disease in areas where it is endemic. Once ND is under control, or in areas where ND is not endemic, farmers will be have a greater incentive to implement the measures suggested in this manual.

1.3 How to use this manual

The manual is in three parts.

- Part 1 gives general information about village chicken production and how to work with chicken producers.
- Part 2 describes management and husbandry practices that will improve chicken production.

- Part 3 deals with various poultry diseases and their control, with special emphasis on ND.

The manual is designed as a practical reference tool for extension workers, livestock officers and field veterinarians. Each chapter details improvements that could be applied by village chicken producers. The key extension messages of each chapter are summarised at its start.

The appendixes provide more detailed information that will assist people working with village chicken producers. While the main part of the manual deals with practical information that would be of direct use to village chicken producers, the appendixes are aimed at providing additional technical information.

- Appendix 1 gives suggestions on how to use this manual as part of a training course.
- Appendix 2 describes participatory exercises that could be used with village communities to identify problems.
- Appendixes 3, 4 and 5 provide information on sample collection and serology.
- Appendix 6 provides sources of other information and further reading.

The order in which information in the manual could be used could vary as follows, according to the principal problem to be addressed in a particular area:

PRINCIPAL PROBLEM			
Newcastle disease (ND)	Part 1 →	Part 3 (plus ND training manual) →	Part 2
Other diseases	Part 1 →	Part 3 →	Part 2
Management	Part 1 →	Part 2 →	Part 3
Supplementary feeding	Part 1 →	Part 2 →	Part 3

1.4 Promoting improved village chicken production using minimal external inputs

Why should extension and development agencies promote improved village chicken production and why should they promote improvements that require minimal extra inputs?

Village chicken production has traditionally been underrated in importance as a vehicle for rural development. This has partly been due to the constraints that ND imposed on the development of this enterprise, but also because women's activities and priorities in rural development in general, and livestock production specifically, have rarely been adequately addressed.

Control of ND in endemic areas opens up further opportunities for improvement that were not previously feasible or considered worth undertaking. There are many improvements offering substantial benefits that can be achieved by farmers from within their own resources without cash expenditure or external assistance apart from appropriate extension advice. Examples would include measures for reducing chick mortality, predation and theft; management of other diseases; and improving flock management.

The benefits of village chicken raising are increasingly being recognised.

- Most rural families, including very poor households, keep some chickens or other poultry species. Chickens are often essential elements of female-headed and HIV/AIDS-affected households. Improvements in chicken production would therefore have a significant effect on most rural families, but especially the poorest and most marginalised people in rural communities.
- Significant returns can be achieved from village chickens without the need for expensive housing, complex technology and funding for the purchase of inputs not available locally.
- Chicken meat and eggs are a source of high-quality nutrients (e.g. proteins and micronutrients) that are often otherwise unavailable to resource-poor families.
- Village chickens are often cared for by women and children and so programs that improve production will simultaneously improve the income and knowledge of these household members.
- Smallholders can produce chickens at little or no cost, which has a very significant competitive advantage over almost any other income-producing activity that they may choose. As such, the activity is essentially financially risk free, with or without ND control.

Interventions and improvements should be designed to take advantage of the natural competitive advantages inherent in village chicken production. There will still be significant risks of disease, predation and theft following ND control and other management improvements. Any interventions that need more than minimal purchased inputs or other cash outlays should be avoided in the first instance, as such may increase poverty and food insecurity.

Table 1 compares the conditions and resources required for extensive, semi-intensive and intensive smallholder production of chickens.

Table 1. Comparison of chicken production systems

Criteria	Extensive rural production	Semi-intensive smallholder production	Intensive smallholder production
Local conditions			
Access to reliable electricity supply	No	Yes	Yes
Existence of cold chain	No	Yes	Yes
Feed source	Scavenging; occasional supplementation	Scavenging; supplementation necessary	Commercial balanced ration
Production/farming system	Mixed, livestock and crops	Usually poultry only	Poultry only
Access to urban markets	No, or indirect	Yes	Yes
Poultry breeds	Local	Commercial or crossbred	Commercial
Flock size	1–50	50–200	>200
Access to veterinary services and veterinary pharmaceuticals	Sometimes	Yes	Yes
Source of new chicks	Natural incubation	Commercial day-old chicks	Commercial day-old chicks
Poultry housing	Sometimes; usually made from local materials	Yes; conventional materials; houses of variable quality	Yes; conventional materials; good-quality houses
Time devoted each day to poultry	<30 minutes	1 hour	>1 hour
Other livestock raised	Usually	Sometimes	No
Inputs required			
Training	Basic: Newcastle disease (ND) control, highly pathogenic avian influenza (HPAI) control (in affected areas); fowl cholera control (in some areas); poultry husbandry and management	Moderate: control of ND, HPAI, infectious bursal disease/Gumboro disease, fowl cholera and fowl pox; breed selection; supplementary feeding; appropriate housing; husbandry; financial management	Considerable: wide-ranging disease control; breed selection; use of balanced ration; good housing; husbandry; financial management
Veterinary services and pharmaceuticals	Minimal	Essential	Essential

Source: adapted from Alders (2004)

1.5 Gender and village chickens

Knowing who is responsible for raising village chickens is of the utmost importance when planning to improve production.

The analysis of gender relations is of major importance for any type of intervention in rural areas, because the paradigms of access, control and benefits of the resources and consequently of exclusion are based on the social relations between men and women. As a consequence, the understanding of gender relations and their implications for livestock raising are important to promote appropriate interventions.

The different members of the household can have different, even contradictory, interests in agricultural production and livestock. The processes of decision-making in households and communities are complex and dynamic. Although male and female farmers have a lot in common, they often have different interests and problems. Men and women may have different interests in relation to animals they have access to and control over. With the animals raised, each species plays a specific role and is owned and cared for by different individuals in the household. These issues have to be considered in the interest of establishing successful collaboration and dialogue with male and female farmers.

1.6 Newcastle disease and avian influenza control, and other production improvements

It is estimated that control of ND alone could increase household income derived from village chickens by 40–60%. Furthermore, when ND control is coupled with other simple production initiatives, household income could increase by around 80% above pre-ND control levels. Although these figures are only estimates, they illustrate the value to be gained from a holistic approach to ND control, where the potential impact of ND control can be doubled if some additional measures are adopted by farmers. These measures involve little additional expenditure by government, donors and households.

Case study:

Sra Luisa Arnaldo, a 36-year-old widow with three children lives in Chirodzi-Ponte, Mozambique. She started raising three chickens in 2000 but the number did not increase due to regular outbreaks of ND. In the middle of 2003, she started to vaccinate her chickens and has since participated in five vaccination campaigns, paying Mozambican metical (MZM) 500 (US$0.025) per bird to the community vaccinator. In October 2004, she had 25 chickens and decided to sell 5 roosters. The roosters sold for MZM45,000 each (i.e. US$2.25), raising a total of MZM225,000. She used MZM150,000 to buy a goat that has subsequently become pregnant. At the time of the interview, all of her children attend primary school.

The effective control of ND, and the associated reduction in mortality, contributes greatly to the early detection of HPAI. HPAI must be considered when high mortality occurs in a flock already vaccinated against ND.

1.7 Village chicken production and HIV/AIDS mitigation

Village chickens require the lowest capital investment of any livestock species and they have a short production cycle. They also play an important role in households where there is a lack of able-bodied workers, such as those affected by HIV/AIDS or which have a disabled family member. Goats and cattle require herders to stay with them during the day, but this is impossible in households without working adults.

In households headed by widows, children or grandparents, chickens represent the easiest species to raise for sale and home consumption, providing a source of high-quality proteins, energy and vitamins, all of which play an important role in the nutrition of HIV/AIDS patients. It is generally acknowledged that poultry production is the most efficient and cost-effective way to increase the availability of high-protein food. Eggs are also a good source of other essential nutrients and can be stored under village conditions more easily than most foods of animal origin.

Families affected by HIV/AIDS will be more likely to make use of the benefits of chickens and eggs if veterinary services work in collaboration with education and health ministries. Improved chicken production and use of chicken meat and eggs can be incorporated into an overall strategy for supporting households affected by HIV/AIDS.

1.8 Organic village chicken production

As economies grow, consumer preference tends towards high-quality meat and eggs that are free of undesirable residues. Examples of the marketing and export of village chickens to supply this growing market already exist in South-East Asia and opportunities exist in Africa.

Farmers interested in producing organic village chickens should therefore avoid the use of antibiotics, insecticides and other products that could leave chemical residues in their birds. Products such as antibiotics and insecticides tend to be expensive and, in many cases, their use in village chickens is of questionable long-term value. Indeed, the misuse of antibiotics can cause the development of resistant strains of bacteria, making the antibiotics less effective.

1.9 Village chicken production and wildlife conservation

The development and maintenance of national parks in many countries must address the multifaceted needs of biodiversity conservation, sustainable tourism development and communities living in the vicinity. Initiatives that

bring government, communities, non-government organisations (NGOs) and commercial ventures together to stimulate economic linkages, local participation and partnerships promote both biodiversity and increased wellbeing among local communities. Improved village chicken production in communities surrounding national parks can reduce hunting of wildlife for consumption and income.

2 General information about village chicken production

2.1 The village chicken system

Chickens are kept under a variety of husbandry systems, ranging from scavenging flocks to birds confined in pens and cages for their entire lives. Village farmers have flocks made up of chickens of various ages of both sexes. The flock is generally allowed to forage freely (or scavenge) in the village, forest, fields and along roadsides. This is very different from the commercial chicken production system which requires far greater management of the chickens and is more costly (Table 2).

Table 2. Comparison of village and commercial chicken production factors

Factor	Village chickens	Commercial chickens
Labour inputs	Minimal	Considerable
Housing	Trees; chicken houses of local material; inexpensive	Chicken unit using conventional materials; expensive
Nutrition	Scavenging feed resource base, leftover food, cereals, no supplements; inexpensive	Balanced commercial ration; expensive
Water	Well water, used water, natural sources	Clean water supply essential
Production	Low; could improve with better nutrition, disease control and shelter from predators	High; but requires a high level of inputs
Meat quality	Little fat; pleasant flavour; tougher texture	Broilers have more fat; less flavour; softer texture
Adaptability	Good: good flight skills, more likely to escape predators, can scavenge for own feed	Limited: poor flight skills, easily caught by predators, less skilled at scavenging
Reproduction	Good hatching and mothering ability; hens lay, brood, hatch and look after young	Poor hatching and mothering ability; commercial breed hens often do not go broody; new birds are bought to replace old birds
Veterinary inputs	Very limited; Newcastle disease vaccination	Control of many viral, bacterial and parasitic diseases essential for efficient production
Environmental impact	Minimal: can be positive through provision of organic fertiliser and pest control	Negative: intensive production of cereals for rations; occasional improper use of antibiotics; excess ammonia production

The unimproved scavenging chicken system has the following characteristics:

- **Low input/low output.** Owners put in small amounts of time and money with the expectation of low returns. This is especially so where there is no ND control, as there is a high chance that most of the chickens will die from this disease in endemic areas.

- **Care of chickens is generally one of many female domestic tasks.** People like to have chickens around but spend only a relatively small amount of time or labour on them every day. Their care is mainly the responsibility of women and children. As frequently happens with activities performed by women, chicken raising is often not recognised as 'real' work even although the birds must receive daily care.
- **Small-scale.** On average, a family has 5–15 birds and, since the mortality rate is high and few eggs are produced, they barely manage to maintain these numbers from generation to generation.
- **Subject to high mortality rates.** Causes of mortality include predation, malnutrition, disease and exposure to the elements; with exposure to the elements often occurring in the first few weeks of a chick's life.
- **Well-adapted to village conditions.** Due to their scavenging ability and the agility to escape predators, village chickens can survive where improved breeds would not. Productivity is relatively low due to genetic potential, low levels of feed and other inputs and, in the case of egg production, the requirement for the hen to brood around three batches of chickens each year.
- **Can make use of locally available feeds.** The chicken finds its own feed around the house or village. This feed is finite and variable, depending on the area and time of year.
- **A source of high-quality nutrients and income.** Despite the relatively low productivity in terms of meat and eggs, village chickens are an important source of high-quality protein for household nutrition. They also provide income for poor rural people. The village chicken can convert feed not eaten by humans into high-quality food. Neither do village chickens require large quantities of human food such as maize, so they do not compete with families for scarce food resources.
- **Independent of large financial investment.** Some form of housing may be provided for the chickens but this is often rudimentary. Owners may house chickens inside the family home at night-time to protect them from predators and theft. They do so despite the increased risks of infection or infestation, as very poor families put immediate security concerns ahead of uncertain biosecurity risk.
- **Self-replicating.** The traditional hen is a good incubator and mother: she arranges her own nest, lays a clutch of eggs, incubates the eggs and looks after the chicks that hatch.

2.2 Comparisons between village chickens and commercial chicken production

Village chicken production differs considerably from commercial chicken production not only in terms of inputs and productivity but also in the occurrence of and susceptibility to diseases. The differences are related to the type of birds used as well as to husbandry and flock management.

Tables 2 and 3 outline the main differences between village and commercial chickens and the factors that influence the health of chickens kept under each production system.

Table 3. Differences in flock health management between extensive (village) and intensive (commercial) chicken production systems

Village chicken production	Commercial chicken production
Advantages: • Local breeds are adapted to harsh conditions, and resist diseases and poor husbandry conditions much better than breeds used for commercial production. • Scavenging chickens are free to choose their feed (provided that there is enough) and escape difficult conditions. Due to this, the consequences of poor husbandry and nutrition are not as severe as in intensive production systems. • A village chicken flock consists of birds of various age groups. Since several diseases affect only certain age groups, the effect of these diseases will not be as devastating as in flocks where all birds are the same age. • Little veterinary input is required.	*Advantages*: • 'All-in – all-out' principle (all birds of a flock are bought and sold at the same time) allows thorough cleaning and disinfection before the introduction of new birds. Proper cleaning and disinfection guarantees good conditions for the new flock. • Hygiene measures (e.g. limited contact with other birds, people, animals or equipment that might transmit an infectious disease) are quite easy to implement. • Veterinary interventions such as vaccination or application of commercial drugs are easier to conduct when birds are confined.
Disadvantages: • There are almost always birds in the flock (no 'all-in – all-out' principle) that could transmit any infectious agent to newly introduced birds. • Under scavenging conditions it is difficult to avoid contact of chickens with other birds, people, animals or equipment that might transmit an infectious disease. • Chickens on free range without supplementary feeding will suffer when the scavenging feed resource base is low (because of the season or because there are too many chickens) and consequently can have poor health.	*Disadvantages:* • Commercial breeds with high productivity are less resistant to diseases than village poultry. • Commercial flocks require comprehensive vaccination programs and regular veterinary observation to ensure efficient production. • Birds kept in intensive production systems rely completely on balanced nutrition, good housing conditions and veterinary care. If any mistake is made, the health of all birds will decrease. • Since all birds in the flock are the same age and should be in the same condition, any outbreak of disease will affect all birds. • Infectious diseases spread faster in large, dense flocks.

2.3 Production characteristics of village chickens

Basic production characteristics for village chickens are as follows:

- Hens start laying when 24–30 weeks' old (Figure 1). At any given time, only about half the hens are productive and some 8–10% never lay.
- Egg weight averages 40 g (range 27–65 g).
- Most birds produce 2–4 clutches per year, although some birds may produce 5–6 clutches. There are about 10 eggs per clutch, with a range of between 5 and 20.
- About 70–90% of the eggs will hatch (this varies with the season).
- Typically, about 8 chicks per clutch will hatch, with a range of between 4 and 15.

- Only 20–50% of chicks hatched will reach adulthood. Approximately 85% of these losses occur in the first 3 weeks of life. Adult mortality is very variable and depends on specific local conditions and the occurrence of diseases.
- Both sexes have a body weight of about 0.5 kg at 10–12 weeks (although males are slightly heavier). Adult hens weigh between 1.0 and 1.5 kg, while roosters weigh between 1.3 and 2.5 kg.

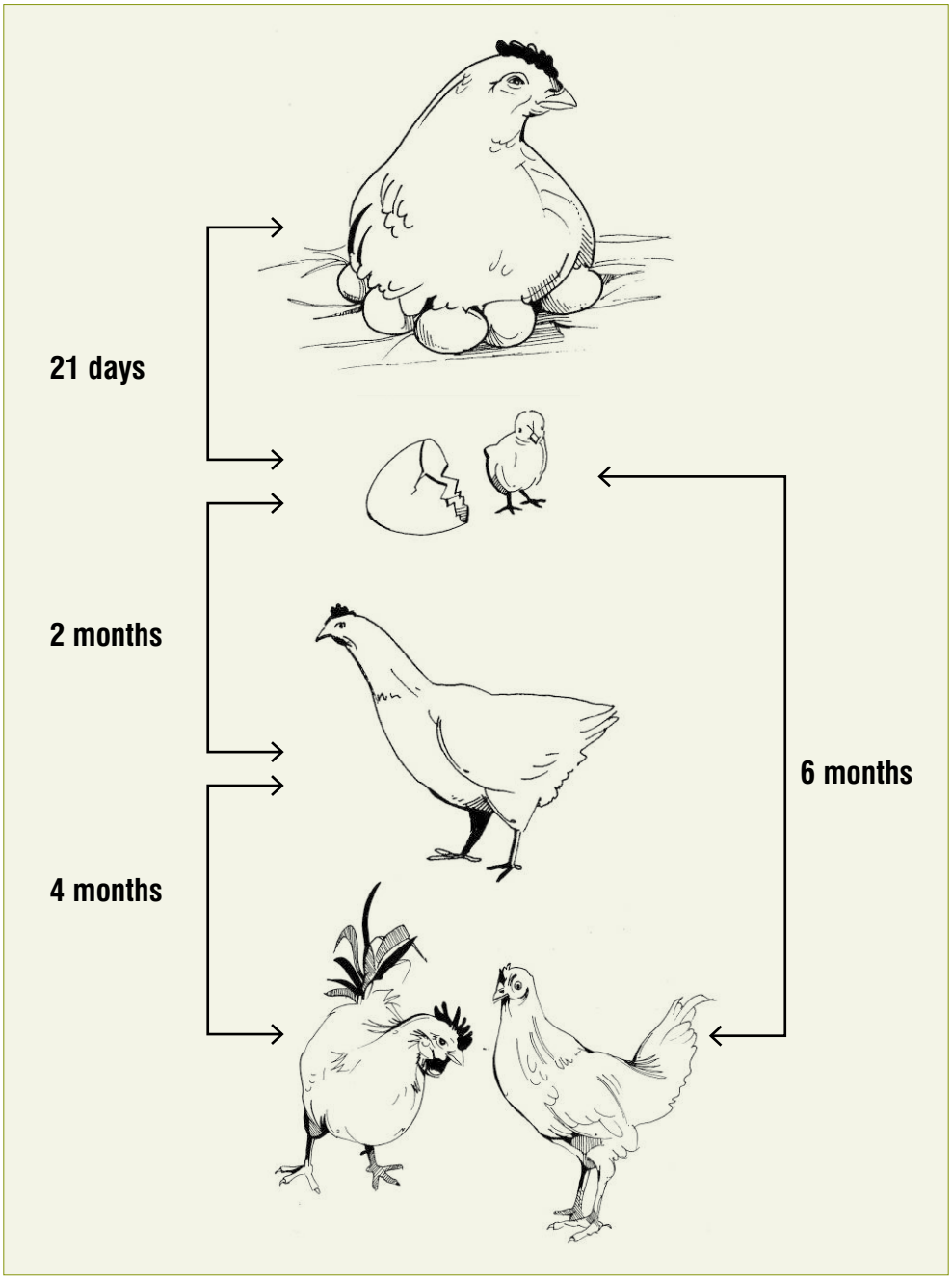

Figure 1. **The life cycle of a typical village chicken**

2.4 The scavenging feed resource base

Scavenging for feed is a major characteristic of extensive poultry-keeping systems. Birds are free to forage and they usually manage to get a reasonably balanced diet. Nevertheless, their diet is restricted in quality and quantity to what they manage to find. The locally available feed is called the 'scavenging feed resource base' (SFRB). The SFRB is limited and has to be shared by all birds in the area.

The scavenging feed resource base:

- comprises household waste, crop by-products and a range of food from gardens, fields and wastelands
- varies from one area to another, with season, with the size and wealth of the household, and with the area that the chickens have to roam (the village population density)
- is generally greater during the wet season, reaches its peak following the harvest (with increased crop residues and waste from higher family food intake) and gradually declines as the dry season progresses and green grass and leaves disappear
- is generally greater in areas where rainfall is higher and there are more-diverse household-sourced feeds such as coconut waste, cassava and horticultural waste
- may be limited in arid areas where the poorest families survive on a minimal area of crops such as maize, sorghum, millet or cassava. They cannot afford animal draft power and so the area cropped depends on family labour only, and household gardens provide few pickings.

The SFRB is an important aspect to consider when promoting improved village chicken production. Control of diseases and improved management will result in a larger number of birds in a village. If this is not carefully managed (through the consumption and sale of additional birds) then the village environment will not be able to support the nutritional requirements of these larger flocks.

3 Working together with male and female village chicken producers

3.1 Introduction

When commencing a program to support village chicken production, it is advisable to first work with male and female farmers in the village to determine:

- what is the current level of chicken production in the village or area?
- what are the main constraints to production?
- what options are available to reduce the impact of the identified constraints?
- what is the best way to promote the chosen options?

Newcastle disease is often, but not always, the most important constraint to village chicken production. It is best to work with a village community to understand the role that chickens play within the farming system and the major constraints that limit production. This process is not only helpful to the extension agencies, but also assists men and women to think about the crucial role of chickens and to encourage the community, and specifically the women, to work with extension services to improve production.

Once ND has been controlled, participatory techniques may also be useful to identify other production constraints and to help the community to evaluate the changes that follow ND control and other management activities.

This section outlines how an extension agency can work with a village community to promote informed decision-making and problem resolution based on a respect for male and female farmers and the principles of community participation and gender sensitivity.

Gender-sensitive methodologies and gender awareness should be included in:

- training of trainers, extension staff and vaccinators
- the introduction of activities into villages with participatory rural appraisal exercises and selection of vaccinators
- a baseline survey and subsequent application of a questionnaire for evaluation of the impact of ND vaccination campaigns
- participatory monitoring and evaluation of the impact of ND vaccination campaigns and other interventions
- ongoing monitoring and refinement of the program.

The process is divided into a number of phases that involve:

- awareness-raising activities and problem identification
- deciding what are the best means of overcoming the identified constraints and planning activities within the community

- implementing the activities
- monitoring and evaluating the results.

3.2 Phase 1: Raising awareness and identifying problems

1. One or more meetings should be held with male and female village leaders to discuss the importance of, and constraints to, chicken production and what can be done to improve production. Leaders can include government representatives, traditional and religious leaders, farmers' and women's organisations, school teachers, healthcare staff and cultural groups. The objective of these meetings is to introduce the extension team to the leaders, discuss the types of support and activities that can be implemented, confirm villagers' interest and define the ways in which the community and its leaders will participate. The importance of the role that women play in chicken raising should be discussed, and ways proposed to ensure their active participation in all phases of the intervention.

   A meeting should then be held with the whole community to discuss the constraints to village chicken production. The agenda for the meeting should enable coverage of items such as:

   - an introduction of the extension team and an explanation of their various roles
   - emphasis that the major aim of the program is to help villagers fight poverty by improving poultry production
   - a reminder that you are there to help them to resolve problems relating to local chicken production, not to distribute free goods to people
   - a number of group exercises with the community to help characterise chicken production, identify the role that men and women play in this activity and the main constraints to production in the village
   - facilitation of community planning and implementation of activities that aim to resolve the identified problems
   - confirmation that the community is interested in working with you to improve chicken production.

2. The final part of this phase involves organising and conducting a number of participatory exercises with the community; with men and women separately, if possible. Examples of participatory exercises are described in detail in Appendix 2, but the list there is not complete and other exercises could be used. Furthermore, it may not be necessary to conduct all of the exercises described in Appendix 2, and extension agents should select those that they think are most appropriate to local circumstances.

   The main aim of the participatory exercises is to use techniques that involve as many members of the community as possible and to work with male and female farmers to describe the current situation and identify problems and possible solutions.

Organising community meetings

Community meetings should be organised with the permission of, and in conjunction with, village leaders. Select a day and time when the maximum number of people can attend. Village leaders will probably know the best way of informing the community about the meeting, although extra publicity could also be provided by the extension services, if necessary. This could include the use of notices, megaphones, and informing teachers and religious leaders about the meeting.

It is important to encourage the participation of men and women, and of poorer or more marginalised families in the community. Women are often responsible for the care of poultry, while poorer families stand to benefit most from improved chicken production. Promote this participation in any discussion with village leaders and in any publicity activities. Remember to consider the needs of these groups when planning the time and location of meetings.

3.3 Phase 2: Identifying solutions and planning activities

Phase 2 is implemented immediately after Phase 1.

1. Organise a meeting with all the residents to give feedback on the information collected from the participatory exercises in male and female groups and to decide how best to solve the constraints identified.
    - The results of the exercises are presented and discussed with the community.
    - Further participatory exercises can be used to explore the best solutions to the problems and constraints that the community has identified (see Appendix 2 for examples of exercises).
    - It may help to ask the community if they would like to nominate a poultry group or committee that would be the main focal point for organising and implementing poultry activities in the community. A group such as a livestock or agricultural committee may already exist in some villages. While the group should be selected by the community, the extension agents should try to ensure that its members are representative of male, female, and poor and disadvantaged people as well as leaders. A balance in terms of gender should be achieved.
    - According to the decisions taken, other meetings and interventions can then be planned.
2. If a group has been selected, organise a meeting with its members to help define their roles and responsibilities and to start planning activities based on the discussions held with the community. Appendix 2 contains ideas on how to assist this process.

3. Once plans have been made, meet with the community to discuss and approve the final strategy.

3.4 Phase 3: Implementing activities

Activities should be implemented as a joint process between the community, the local poultry group (if there is one), other leaders and community groups, and the extension agency.

It is important to encourage discussion within the community so that everyone can constantly evaluate what is being done and have an opportunity to comment on activities and suggest improvements. Although it is good to try to follow the plans drawn up with the community, activities should be flexible enough to adjust to unforeseen problems.

3.5 Phase 4: Monitoring and evaluating the results

Monitoring and evaluation (M&E) is an ongoing process of continually looking at plans and activities to try to improve what is being done. The extension agency and community may wish to organise a formal M&E strategy so as to better guide the whole extension process. However, even if that is not possible, extension agents and community members should continually evaluate what they are doing in an informal way so as to identify and resolve problems at an early stage and always be seeking to improve the way they are doing things. This mainly involves promoting an attitude of persistently questioning how things are going and how they can be improved.

Evaluation activities should include, at the least, regular meetings with the community and/or the community poultry group to discuss the implementation and results of activities. Some of the earlier community exercises in same-sex groups can also be regularly repeated (perhaps once per year) to see what changes are happening. These exercises may include:

- family roles related to chicken raising
- chicken-raising calendar
- ranking of activities according to their contribution to household income
- ranking of problems related to chicken raising
- focus group discussions
- case studies.

Appendix 2 describes how to conduct these exercises.

PART 2
Housing, nutrition and management

Newcastle disease is endemic in village chicken flocks in many countries. Since it regularly devastates family flocks, farmers have little incentive to improve productivity by investing in additional husbandry or management interventions such as improved housing or supplementary feeding. Now, however, the advent of effective thermotolerant vaccines has significantly improved the control of ND in villages. In areas where there are regular vaccination campaigns, it is worthwhile considering basic husbandry techniques that could increase the amount of chicken meat and eggs available for household consumption and for sale.

Villagers value their chickens but they are most often just left to fend for themselves under completely free-range conditions. The chickens find their own feed and water, breed at random, lay their eggs where they find it suitable to do so and raise their chicks on their own. Villagers slaughter or sell their chickens only when necessary and, in many regions, eggs are not collected for sale or consumption but rather left for the hen to hatch.

Farmers are often cautious of change and are naturally wary of taking on added risk or adopting practices different from those that have worked in the past. This is especially so for poorer farmers, as they are putting at risk the lives and health of themselves and their families. Management changes should therefore be introduced gradually. In addition, extension staff should undertake participatory exercises with the community to find out what are the most serious problems and which practices would have the greatest chance of being adopted. Start with those practices and then introduce other improvements once farmers have seen the benefits of the innovations.

The three main chapters in this part of the manual describe simple management practices that will help to turn village farmers from passive observers of their chickens into active producers, while still using minimal labour and other inputs. Chickens can become a more productive and important part of the farming system with little financial risk and impediment to the other activities of farmers.

Flocks from different households in a village intermingle, interbreed and share the same feed resources. Hence, families should be encouraged to work together with their neighbours and learn from each other.

4 Chicken housing and shelter

4.1 Introduction

Housing village chickens at night will protect them from rain and the cold, from predators such as rats, snakes and other wild animals, and dogs, and from theft. Also, housed birds are easier to catch to inspect for signs of illness or injury, or to vaccinate them against diseases.

Since exploitation of the scavenging feed resource base is one of the major advantages of the low-input village chicken production system, housing for adult and older growing birds should be provided only at night and the chickens allowed to free range for feed during the day.

4.2 Types of housing

Adult birds and growers are often provided with elevated night housing (Figures 2 and 3).

Figure 2. **Houses built on poles to raise them well above the ground protect the chickens from predators such as rats, snakes and other wild animals, and dogs. They can also have inverted metal cones around the legs to prevent snakes and rats climbing them.**

Chicken houses built close to the ground are suitable for hens with young chicks that cannot enter an elevated house. It may be necessary to dig a drain around such a house or to raise the floor, so that it will stay dry during the rainy season. The cage shown in Figure 4 does not have a floor and can be moved to a new place every day or two. Chickens can be housed in these cages overnight or confined in them for some time during the day. The chickens scratch the ground to find feed for themselves. A house like the one in the drawing is about 4 m long, 1 m wide and 1.5 m high. It can hold 8–10 adult birds if they are kept enclosed all day, or about 20 for overnight housing. The house can be completely covered with wooden slats or be partly open with netting or woven bamboo. This type of house may also be suitable for holding a hen with her young chicks for the first week or two after hatching.

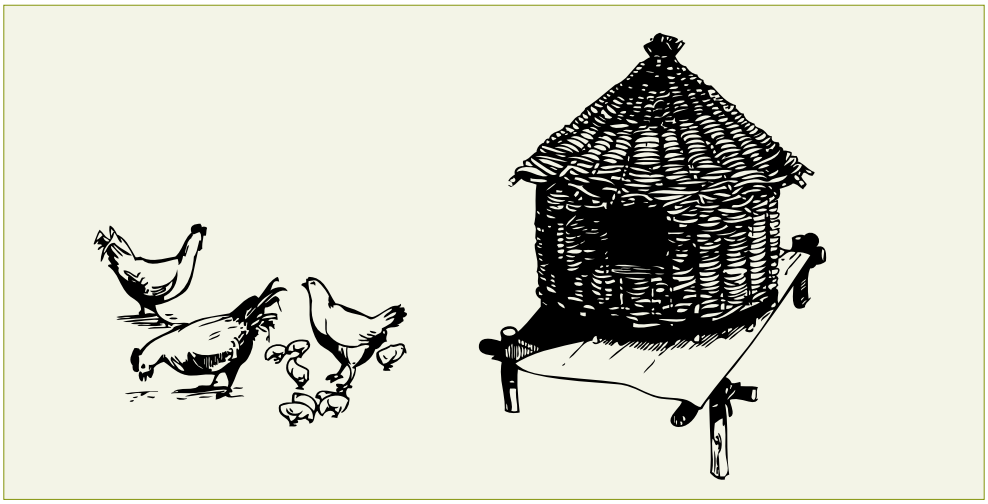

Figure 3. **Locally made cages can be moved easily and kept off the ground. They may be used to keep chickens inside the house overnight or to separate newly introduced or sick chickens from the flock for several days. This locally made house is easy to move and can be put on a metal or wooden sheet above the ground.**

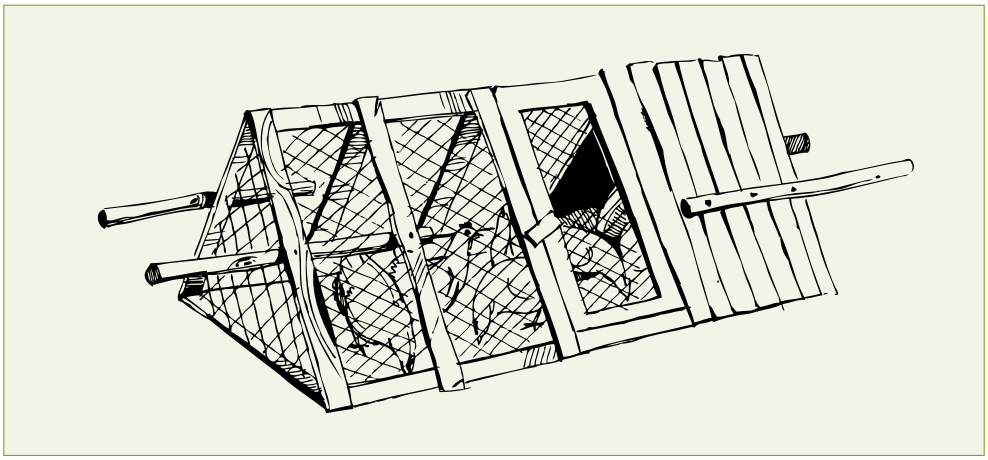

Figure 4. **Another type of large cage that can be moved easily**

4.3 Constructing a chicken house

The following are some simple rules for building a chicken house.

- Clear the grass and bush for about three paces (3 metres) on all sides of the house site to keep snakes and rats away from the chickens.
- A house can be built cheaply using local materials such as tree and bush branches or reeds and thatch grass.
- The size of the house will depend on how many birds the villager has (or plans to have) and if they are to be kept in the house overnight or for longer periods. For 10–15 adult birds, the size of the house should be about one large pace (1 metre) wide by one to two large paces long. If too many birds are kept together they may start to peck each other, leading to injury and diseases.
- Always remove the bark from timber used to construct the houses so that pests and parasites such as ticks and mites will have nowhere to hide.
- The house should protect the chickens from rain and wind but have enough ventilation to provide birds with fresh, clean air.
- The opening should be wide enough to allow the inside of the house to be cleaned easily and should be fitted with a door or other means of closure.
- Because many infectious diseases of chickens are transmitted via their droppings, the floor of the house should be slatted to allow the droppings to fall through (e.g. by using branches as a floor). The spaces between the slats will depend on the age and size of the chickens, ensuring they have adequate foot support and that droppings can pass through.
- If the chicken house is built on poles, it should be at least 60 cm above the ground but not so high that the inside of it cannot be reached by the villager.
- Putting inverted metal cones around the poles of a chicken house will make it harder for rats and snakes to get into it.

4.4 Roosts/perches

Perches are favoured by chickens, as they like to sleep above the floor. Roosting on perches will minimise the contact between the birds and their droppings, and therefore help to prevent diseases. The roosts can be made from bamboo or straight tree branches (remember to debark the branches). They should be about 3 cm in diameter. Each adult chicken requires about 20 cm of perch space. If more than one perch is needed, the perches should be about 50 cm apart and at the same level. If they are at different levels, the birds will fight to reach the highest perch when they come in to roost in the evening, causing unnecessary stress.

4.5 Maintaining a chicken house

Cleaning the chicken house helps to prevent and control diseases, especially external parasites such as fleas and mites. The following procedures should be adopted.

- Remove droppings and litter from the inside of the house regularly (once a week) or, if the house is portable, move it to a fresh area.
- Fumigate the chicken house regularly with smoke (by lighting a fire under elevated chicken houses or placing cages above kitchen fires) to control external parasites (every 6 months).
- Clear the grass and bush around the chicken house to keep snakes and rats away.
- Do not overcrowd the chicken house.
- Empty a house where sick birds have been; clean it or even burn it and build a new one.
- Regularly remove the droppings from underneath the chicken house; compost them for at least 3 weeks, then place the manure on gardens, mixing it into the soil to reduce the chance of diseases and parasites accumulating and to prevent flies from reproducing in it. Flies will not be a problem if the manure is kept dry.
- Place wood ash or lime on the floor and walls to repel external parasites and aid the removal of manure when cleaning.

Safe use of chicken manure

Break up chicken manure so that it dries quickly—this will help to kill infectious agents and the eggs of parasitic worms within the manure. Digging composted manure into vegetable gardens will fertilise the soil, leading to better plant growth.

4.6 Provision of nests

Provision of clean nests in safe places assists in controlling and improving productivity. The quality of eggs is better if they are clean. Moreover, it is easier to find eggs if nests are provided rather than allowing birds to lay eggs in hidden locations.

Locally available items such as baskets, boxes, buckets or similar containers can be used for nests. Pad the containers with clean, dry nesting material (e.g. leaves, straw, old cloth or even sand) to help to keep the eggs warm and minimise the risk of breakage or contamination.

Some tips on the provision of nests follow:

- A sufficient number of nests should be provided: 1 per hen or, if there are more than 5 hens in a flock, 1–2 nests fewer than the number of hens.
- Eggs intended for brooding should not be removed from where the hen laid them, otherwise they might be abandoned.
- Nests should be located in safe places, protected from rain and wind, and out of reach of dogs, other predators and ants.
- Nests should be constructed in a way that protects the eggs from cooling from below or from falling out of the nest (Figure 5).
- Nests should be cleaned regularly.
- Nests that have been used for a long time should be fumigated with smoke (e.g. every 6 months).
- If there has been a serious outbreak of disease or a heavy infestation of external parasites (e.g. lice), the nests should be burnt and replaced using new materials.

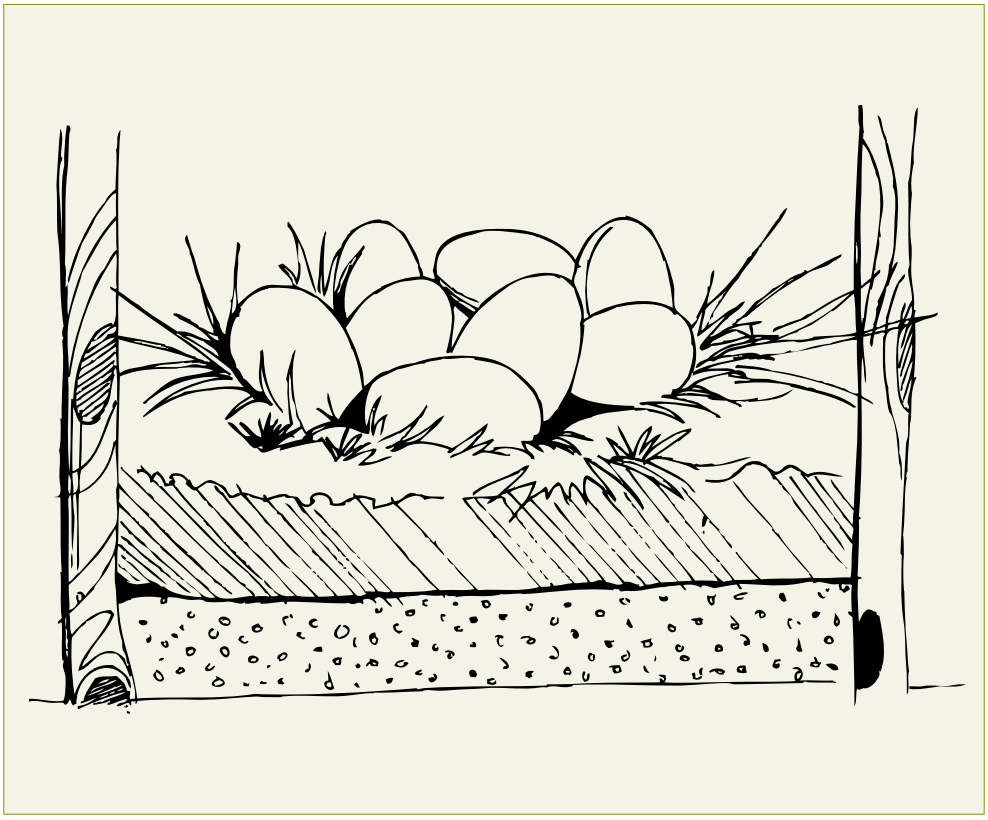

Figure 5. A hen will hatch more chicks if her nest is clean, dry and safe. She will favour a nest that sits above the ground and is provided with clean straw or grass.

4.7 Protection from predators and theft

4.7.1 Predators

Predators are a major problem in village chicken production, causing almost unavoidable losses in free-range systems.

Predators of chickens include other birds, mammals and reptiles, and even ants. Protective measures should be designed around which predators are common in the region and how these predators hunt. Birds of prey often circle high in the air and suddenly dive to catch a victim seen on open ground. Other predators, including some birds, hide in trees in search of their prey. Wild cats, foxes and other four-legged hunters usually prefer to use the cover of bushes to approach their prey unnoticed. Rats and snakes are more likely to catch chicks that are confined or housed. Losses due to ants have been reported only for caged chicks, and where the chick shelter has been built across the ants' nest or path. Farm animals such as dogs also enjoy an occasional chicken dinner and should be kept under control.

Implementation of the following general measures will help reduce losses due to predators:

- Construct shelters to offer protection from predators. Build a chicken house on poles and put inverted metal cones around the legs to make it harder for predators to enter.
- Clear the grass and bush around the chicken house, so as to limit hiding places for predators.
- Do not provide feed or water in extensive open areas where chickens can be attacked easily by birds of prey.
- Do not provide feed or water next to dense bushes where cats, rats or snakes can wait for their prey.
- Hang small pieces of tin in a tree or on a long pole close to the area to be protected. The noise produced and sunlight reflected when the tin moves with the wind might deter predators.
- Chickens with coloured feathers are better camouflaged than unicoloured (e.g. bright white) birds, which are an easier target for a predator.

4.7.2 Theft

In areas where chicken theft is a serious problem, many farmers keep their birds inside the family house during the night, rather than in a separate chicken house. In their opinion, a separate chicken house makes it easier for thieves to steal the birds. However, keeping birds in the house might be unhygienic (especially when the birds suffer from parasites or disease such as HPAI) and, if the flock is big, is impractical.

Keeping the birds in a separate but safe place is therefore strongly recommended. Measures that might be adopted to minimise theft from a separate chicken house include the following:

- The chicken house could be fitted with a very noisy opening that will alert the owner in case of attempted theft.
- Roosts could be placed at more than an arm's length from the opening so that birds are out of reach of thieves. This design is used in northern Malawi. Disadvantages of this type of chicken house are that it is more difficult to clean and for the owners to catch the birds for vaccination.
- The chicken house could be built next to one of the outside walls of the family house.

Nevertheless, when theft is a big problem, farmers may see guarding their chickens inside the house as the only solution. In such cases, to avoid the chickens roaming around the room or even the house as a whole, it would be best to construct one or more portable cages (according to the flock size) that can be placed in any corner. Portable cages should have short legs, and slatted floors to allow the droppings to fall through. Put large leaves, old paper or sacks under the cages to catch the droppings or feathers for easy removal from the house. To avoid fighting inside cages, it is best to provide at least 1 m^2 of floor area for every 10 birds. Another possibility is to construct perches in one corner of the family house (see Section 4.4). This will encourage the birds to roost in one place inside the house. The roost can be placed over leaves, sand, ash or sacks to make cleaning easier.

Daily removal of the droppings and feathers, or cleaning of the place where the birds were kept overnight, is necessary to avoid negative consequences for human health. No inside housing of birds should be practised in areas where zoonotic diseases such as HPAI are present.

5 Nutrition

5.1 Water

Chickens need water for survival, growth, activity and egg production. **Five chickens will drink about 1 litre of water every day** and they will need more than this when it is very hot. Water should be available at all times.

Although chicks can survive for several days without feed, they will quickly die without access to water. Complete water deprivation may result in death in less than a day during hot weather. During hot weather, if a chicken has not had access to water for some time, it may drink too much when it is does obtain water and this could result in diarrhoea. To avoid this, chickens should always have access to fresh, preferably cool water. If water is accidentally forgotten and provided only at the end of a hot day, at first only small quantities should be given.

Scavenging chickens usually manage to find enough water to survive. However, chickens, especially young chicks and laying hens, will perform much better when provided with water.

While clean, fresh water is best, when water is scarce, chickens can be offered used water as long as it contains no detergents or other harmful substances.

Waterers should be:

- not too high, so that all age groups can drink without risk of drowning (Figure 6)
- not too large, so as to avoid contamination with droppings (and ducks bathing in it)
- cleaned daily
- kept constantly in the same place that the chickens get used to (helpful in case of the need to add medication via the water)
- placed where the chickens will be at least risk of attack by predators.

Clay bowls make simple but effective waterers. They should have a flat bottom and vertical sides so that they are not easily tipped over. They should not be so deep that the chicks can drown in them. Waterers need to be cleaned and refilled daily (or more frequently if they become dirty during the day).

Waterers for young chicks should have a lower lip of approximately the same height as the backs of the chick, so that the chicks can easily reach the water but not dirty it. Place stones on the floor of the waterer so that the chicks will not drown if they accidentally step into it.

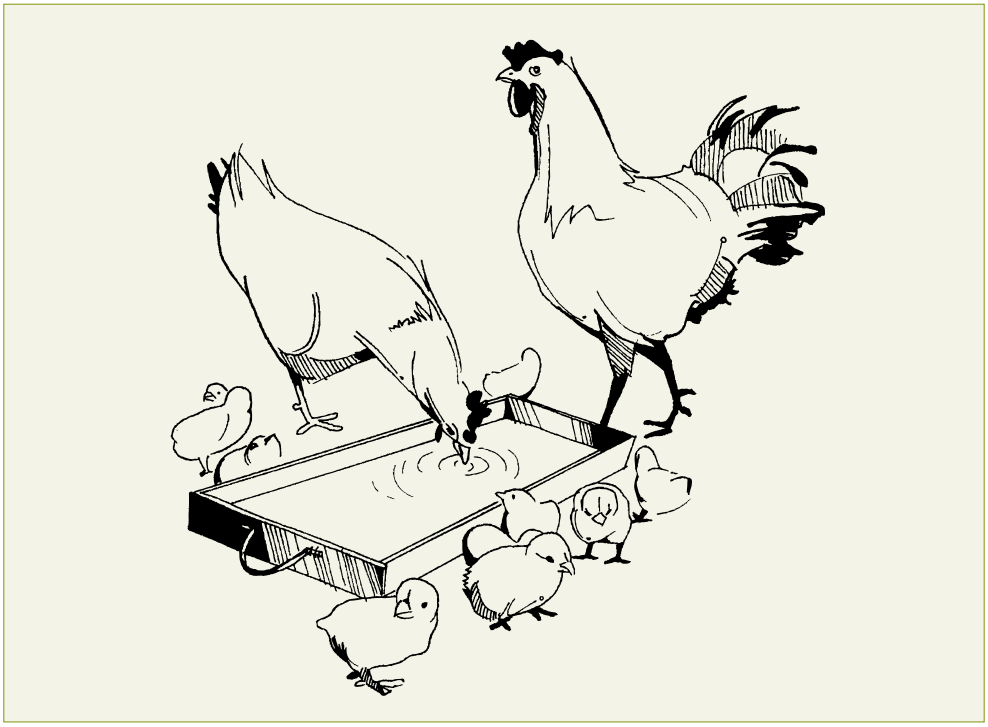

Figure 6. **A chicken can live for several days without eating but if it does not have water it may die within a day during hot weather. It is very important that chickens always have access to water—preferably clean and fresh.**

5.2 Scavenging

Making best use of the scavenging feed resource base (SFRB) is a major characteristic of extensive poultry-keeping systems. The SFRB includes various types of green feed, seeds and fruits, insects, worms, minerals in the soil, gleanings from cultivated fields, bran when cereals are processed and household food scraps and leftovers.

At some times, the SFRB is deficient in protein-rich feeds while at others, energy-rich feeds may be lacking. The quantity and quality of the feed base is usually the main factor limiting chicken production, and it is essential to take the particular SFRB into account when looking into possible management improvements.

It is essential that farmers keep an eye on their chickens

Farmers should be encouraged to monitor the general health of their flock and the availability of feed around the house. If the flock is generally losing weight or condition, or if there is little feed available around the house, then some supplementary feeding may be necessary if some birds cannot be sold or consumed. They should be advised to keep an eye on young chicks in particular, as these will be the first to suffer and can serve as an early warning sign.

If a farmer is unsure of which type of feed to provide to supplement the SFRB (e.g. more proteins or more carbohydrates), then 'cafeteria' feeding (see Section 5.6.1) may be worth while.

5.3 How a chicken digests food

Chickens pick up feed with their **beaks** (Figure 7). The beak in active birds might therefore be blunt, while a long beak might indicate that the bird is not feeding well. Food is mixed in the mouth and then swallowed whole (since chickens have no teeth). It goes into the **crop** where it is stored for up to 18 hours. The crop can be felt at the right side of the neck when it is full. The food passes from the crop into the **proventriculus** where it mixes with juices that will help with digestion. It then passes into the **gizzard**. The gizzard is a very muscular organ with hard ridges which, together with small stones that the bird has eaten, help to grind up the food for digestion. In the **small intestine**, the food is broken down with digestive enzymes into nutrients that are absorbed through the wall of the intestine into the blood. In the **large intestine**, excess water is absorbed from the food. After nutrients and water have been taken from the food, the residue passes into the **rectum**, the **cloaca** and exits via the **vent** as faeces (droppings).

Birds do not produce liquid urine. Waste from the kidneys forms a thick white material (mostly uric acid) which is mixed with the faeces. Both are then voided through the cloaca as droppings.

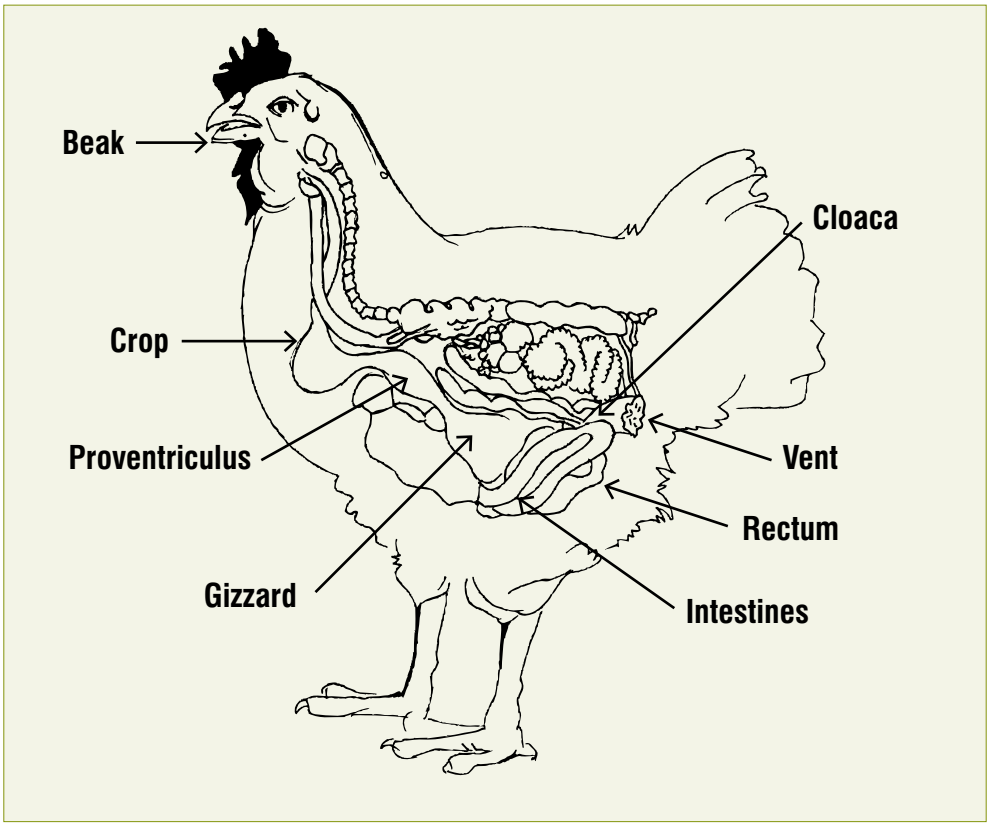

Figure 7. The internal organs of a chicken, highlighting the digestive tract

5.4 What chickens need in their feed

Chickens need adequate feed to maintain their condition (e.g. to move around, renew their feathers, fight diseases), to grow and to produce eggs. Their diet—like the diet of humans—consists of different nutrients: carbohydrates, proteins, fats, vitamins, minerals, crude fibre and water (Table 4).

Table 4. Functions of various nutrients in chicken feed

Nutrient	Function
Carbohydrates	To provide energy (e.g. for movement) To maintain body temperature [Any surplus is stored as fat reserves (in lipid deposits) in the body]
Fibre	To enhance digestion [Crude fibre is itself poorly digested]
Proteins	To replenish the body's muscles, organs and fluids To contribute to the growth of feathers, beak and claws To produce eggs
Fats	To provide energy—fats are very high in energy To maintain body temperature [Surplus is stored in lipid deposits in the body]
Minerals	To build bones To produce eggshells To assist in chemical reactions inside the body
Vitamins	To maintain the body's functions To fight diseases
Water	Essential for all body functions

All these nutrients are necessary to provide energy, grow muscles and produce eggs. Lack or shortage of a single nutrient may result in poor growth or egg production and increased disease problems. The daily feed ration of a chicken must therefore contain certain amounts of carbohydrates, proteins, fats, vitamins and minerals. To make a balanced diet, these nutrients need to be combined in the right ratio, according to the age and productivity of the bird. For example, to optimise egg production in commercial layers, the chicken's diet should be moderate in both energy and protein, while a ration for commercial broilers should contain higher levels of both energy and proteins to optimise the production of lean tissue. Because of their lower rate of production, diets for village birds tend to have lower nutrient specifications.

Sources of nutrients include:

- Carbohydrate-rich feeds—energy feeds—include maize, sorghum, rice, millets, cassava and cooked sweetpotato.
- Cereal brans contain moderate levels of energy and fibre. They are a very useful, and often cheap, feedstuff for chickens but, because of their fibre content, they should not be fed to chickens in large quantities.

- Protein feeds are primarily classified as being of either animal or vegetable origin.
  - Animal products usually have a higher protein content than vegetable products, as well as better-quality proteins. Examples of animal proteins include fish, meat of various origins, blood, earthworms, termites, and other larval and adult insects. Chickens will also eat the ticks off cattle lying in cattle corrals. Eggs are an excellent source of proteins. If available, a hard-boiled egg can be given to young chicks, with an egg a day being sufficient for 6–7 chicks.
  - Among the sources of vegetable proteins are various legumes (e.g. cowpea, pigeon pea, chickpea, mung bean, garden pea, groundnut, sunflower seeds, sesame seeds, pumpkin seeds [after removal of the outer shell] and coconut). Some legumes (including soybean) contain toxic chemicals that must be removed by some form of heat treatment before the feed can be consumed. The legumes mentioned above are known to have little or no toxicity when eaten raw. Certain fermentation processes may improve the protein quality of some beans. Since vegetable proteins are of inferior quality, as many as possible should be combined in any particular feed (e.g. beans and sunflower seeds together provide proteins that are nearly as good as animal proteins). Leaf proteins, including those of grasses, are of better quality than those in seeds—free-ranging chickens eat a lot of green feed, so when they are enclosed their feed should include the leaves they like (e.g. the leaves of bean plants, sweetpotato, pumpkin, cassava and certain wild herbs that people also use as salads and relishes).
- Chickens require, in very small amounts, a wide range of minerals including iron, zinc, copper, iodine and manganese. They must get these minerals from their feedstuffs and the soil. An important mineral required in greater amounts is calcium, which is present in sea and snail shells, limestone in the earth and bones (burnt and crushed). Eggshells also contain high levels of calcium but they should be roasted before feeding to chickens, which will otherwise acquire a taste for eggs and become egg eaters. Phosphorus, another essential mineral, is also present in bones and certain rocks. People often forget the importance of salt—this can be sprinkled in small quantities over any feed given, but too much of it can cause diarrhoea.
- Vitamins are also required in very small quantities. There are many different vitamins, and feeds such as liver, fruits, vegetables and leaves are rich sources of them. Other feeds, such as grains and insects, also contain vitamins in varying amounts.

All the above nutrients are necessary for optimal production but the proportions vary according to age, stage of production, local climate, season of the year and other factors. For example, growing chicks need more proteins than adult birds. Energy-rich feeds usually form the largest part of the diet of chickens (about 60–70%), then come protein-rich feeds, while the various

minerals and vitamins are needed only in very small amounts, except for calcium for laying hens—in layers, the formation of the eggshell requires higher levels of dietary calcium than those needed for non-laying birds.

5.5 Feed resources

Chickens need sufficient good-quality feed to grow, produce eggs and maintain their resistance to diseases. In village chicken systems based on scavenging, the feed resource is a critical constraint to the expansion of chicken flocks once ND is under control.

The SFRB in a village is generally fully utilised. Village populations of scavenging chickens can grow until the SFRB is over-utilised. When the SFRB is not sufficient to nourish all birds (as well as other scavenging animals), birds less able to compete and fend for themselves, like chicks and growers, are the first to starve. Furthermore, the SFRB varies with the different seasons, increasing competition for available feed in times of food shortage.

To avoid starvation of chickens, especially young and weaker birds, the flock size needs to match the locally available feed resources throughout the year. To ensure that this is so, villagers should:

- observe their chickens to see that they are not losing weight through lack of feed, keeping an eye on young chicks in particular, as they will be the first to suffer and can serve as an early warning sign
- be aware of their neighbours' chickens and other scavenging animals when calculating the available feed resources
- reduce the number of chickens they keep in times of feed shortage
- not allow hens to sit on too many eggs, otherwise the chicks that hatch will not find enough food
- provide supplementary feed when the SFRB is depleted and the number of chickens kept cannot be reduced.

In certain circumstances, supplementary feed (either local ingredients or commercial feed) can be supplied. The farmer must be aware that extra feed must be supplied constantly and permanently when the flock size is too big for the birds to receive adequate nutrition from the SFRB. **Malnourished birds are not productive and are more likely to contract diseases.**

Farmers must decide between providing supplementary feed and reducing the flock size. This decision will take into account current and projected levels of chick mortality, the cost of feed, the relative returns from sale of chickens and eggs in the market, and the value placed on home consumption of eggs.

When flock mortality is reduced and production increases, farmers must decide how to deal with a bigger flock. If the SFRB is not sufficient to support the flock, then farmers should ask themselves the following questions:

- Can I afford to keep this many birds at the moment? (factors to consider: the money needed to buy feed; the availability of other supplementary feed; the time involved in looking after the birds)
- Is it better to sell some birds now instead of later? (factors to consider: the current price of birds compared with the expected future price; an important festival or ceremony coming up, for which many birds will be needed)
- Is it necessary to keep this many birds or would it be preferable to consume more birds and eggs at home?
- Should we be selling and eating more eggs rather than hatching so many chicks?

Farmers could use the decision-making sequence shown in Figure 8 when the SFRB is not sufficient to meet the needs of the flock.

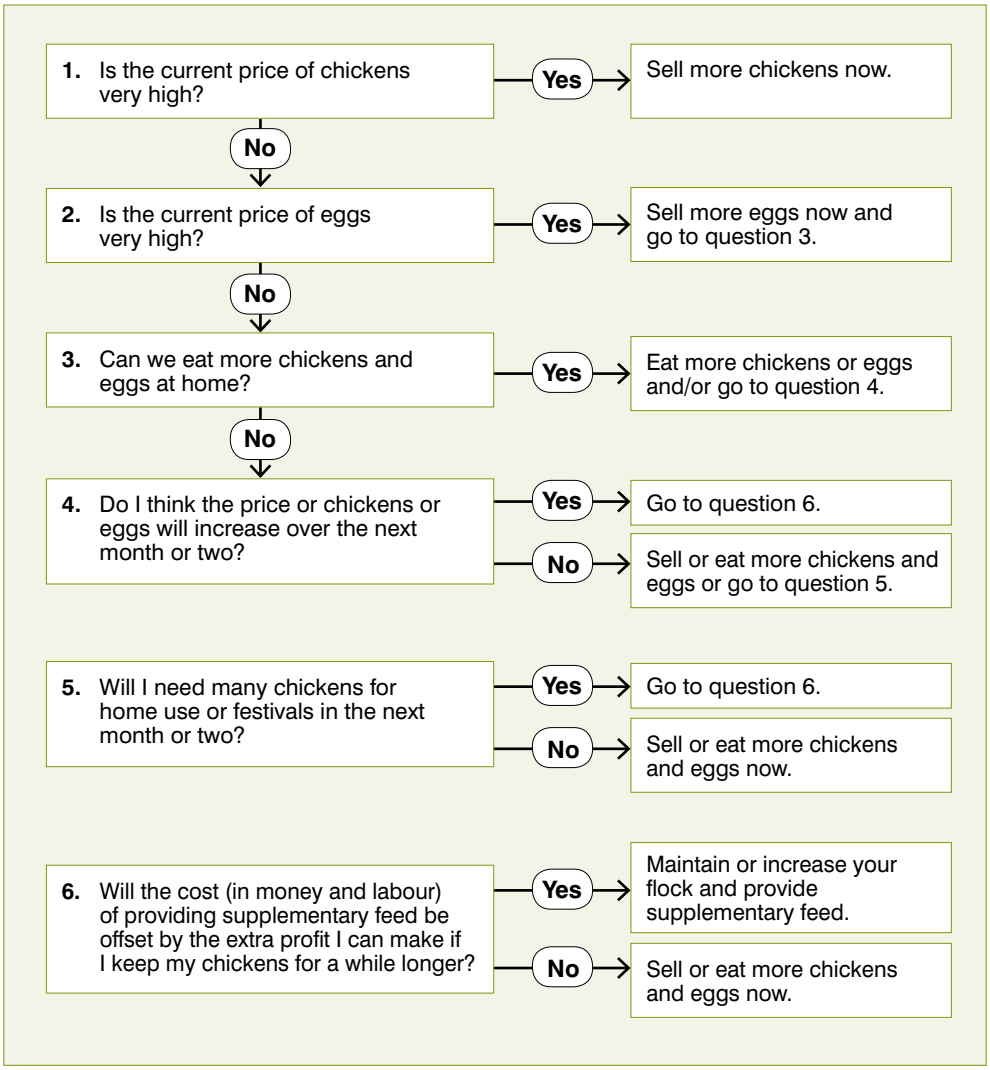

Figure 8. Decision-making scheme for farmers when the scavenging feed resource base is insufficient to meet the needs of their flock

Remember that relying on commercial feed will take away one of the biggest advantages of village chicken production: low input and, consequently, low risk.

5.6 Supplementary feeding

Supplementary feeding can be used to increase the productivity of scavenging village chickens and to assist the chickens when the SFRB is insufficient to allow the whole flock to thrive.

Supplementary feed is just that—a supplement not a replacement—and must therefore not distract the chickens from scavenging. In general, it is therefore best to offer supplementary feed in the late afternoon before the chickens are penned overnight.

Poorer farmers might find it difficult to regularly supplement their chickens' feed. In such cases, supplementary feed might be provided for only selected birds or age groups, such young chicks or laying or brooding hens. If this is done, then a way must be devised to separate the selected chickens from the flock so that only they have access to the supplementary feed.

What can be used for supplementary feeding?

In general, everything edible can be used for supplementary feeding of chickens, but the benefit will be higher when the nutritional needs of the chickens are considered.

Chickens that get all their nutrients from scavenging may eat an excess of proteins and therefore benefit most from supplemental feeding of carbohydrates (e.g. a few handfuls of maize, sorghum or millet). Hens in lay can be provided with a diet rich in proteins and some extra crushed mollusc or eggshells. These contain calcium, an element necessary for the production of the eggshell.

Chickens can be provided with leftovers from household food, as well as green feed such as grass, weeds and leaves from garden plants. Bran (the seed coat but not the husk) from grains such as rice, maize and wheat after polishing is a useful feed ingredient for chickens, containing moderate proteins and energy. The outer husks or hulls have little nutritional value.

Some advice on the provision of supplementary feed:

- Feed should always be provided fresh daily rather than being provided in one big heap for the chickens to finish over a few days.
- Feed should be offered in troughs to avoid mixing with the soil, which spoils and contaminates valuable feed. There are various types of feeders (Figure 9), the best being those that prevent the chickens from stepping onto the feed.

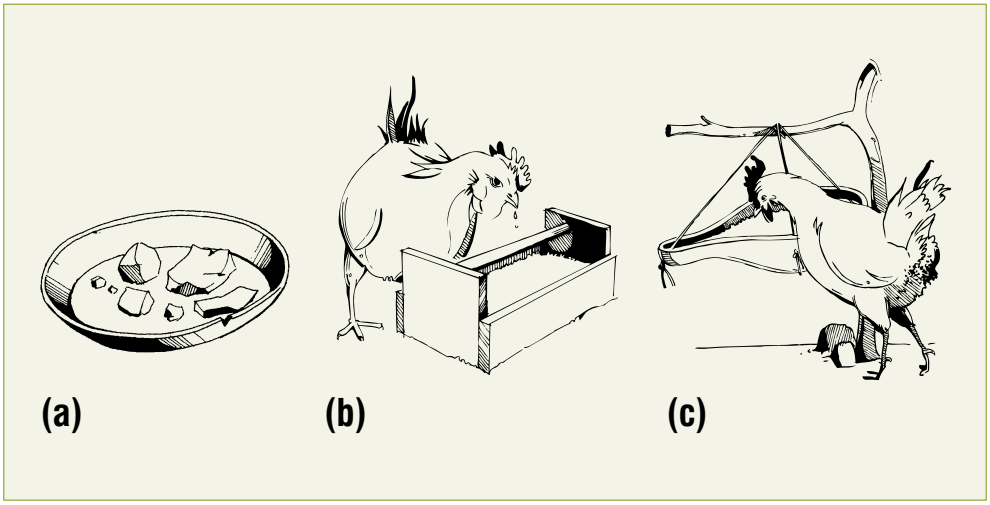

Figure 9. Three types of feed troughs

- Feed troughs should always be clean. Remove old feed daily and clean the trough before refilling. Feed should never be allowed to become mouldy or rotten. Mouldy feeds can cause illness and death of chickens.
- Contamination of feedstuff with faeces should be avoided because many diseases are spread via the droppings.
- Feed should be offered always at the same location so that the chickens get used to it. The feeding place should not be easily accessible to predators (see Section 4.7.1).
- If eggshells are provided, they should be roasted and crushed, so that the chickens do not recognise them as part of an egg. Otherwise, they might start eating eggs from nests.
- Since chicks have very small beaks, feeds such as cereals and beans, as well as some of the minerals provided, need to be ground into pieces small enough for them to be easily swallowed (but not so fine as to be powdery). Leaves and hard-boiled eggs should be finely chopped for chicks. Chicks have a very limited capacity to ingest and digest high-fibre feedstuffs.
- Some simple procedures may improve the nutritive value and/or digestibility of certain feeds. For example, bean or pea seeds should be kept moist in a covered container and allowed to germinate before feeding them to chicks. Cereal grains can be soaked in water overnight to improve their digestibility. Since such materials can become mouldy, it should be ensured that the chickens eat them as soon as they are offered.

The suggestions above assume the production of a variety of crops surplus to the family's needs. Farmers will generally increase crop production when there is a market for the crop plus products available that they want to buy (assuming there is suitable land and weather conditions to increase production). Similarly, village chicken farmers may also decide to produce more crops for feeding chickens once they see the value of having more meat and eggs to eat and sell.

The importance of making clean water always available for chickens cannot be overemphasised. Scavenging chickens find much of the water they need by themselves, but having extra water available will greatly improve their productivity and chances of survival, especially during dry weather. Young chicks, in particular, need easy access to clean water. Remember that an adult chicken drinks about a quarter of a litre a day, and more when the weather is hot. When it is hot, try to keep the water as cool as possible by locating it in the shade. Section 5.1 has further information on chickens' water requirements.

5.6.1 Suggestions for producing supplementary feed

Some supplementary feed for chickens can be produced from materials that are available from around the house. Although it would be difficult to produce enough locally made supplementary feed to support a whole flock of birds for any length of time, the suggestions below could provide some extra feed during dry times of the year, or for layers or young chicks that would benefit most from the extra feed. When preparing feed, remember that birds have no teeth and so their feed will be used more efficiently if it is presented in small pieces (Figure 10).

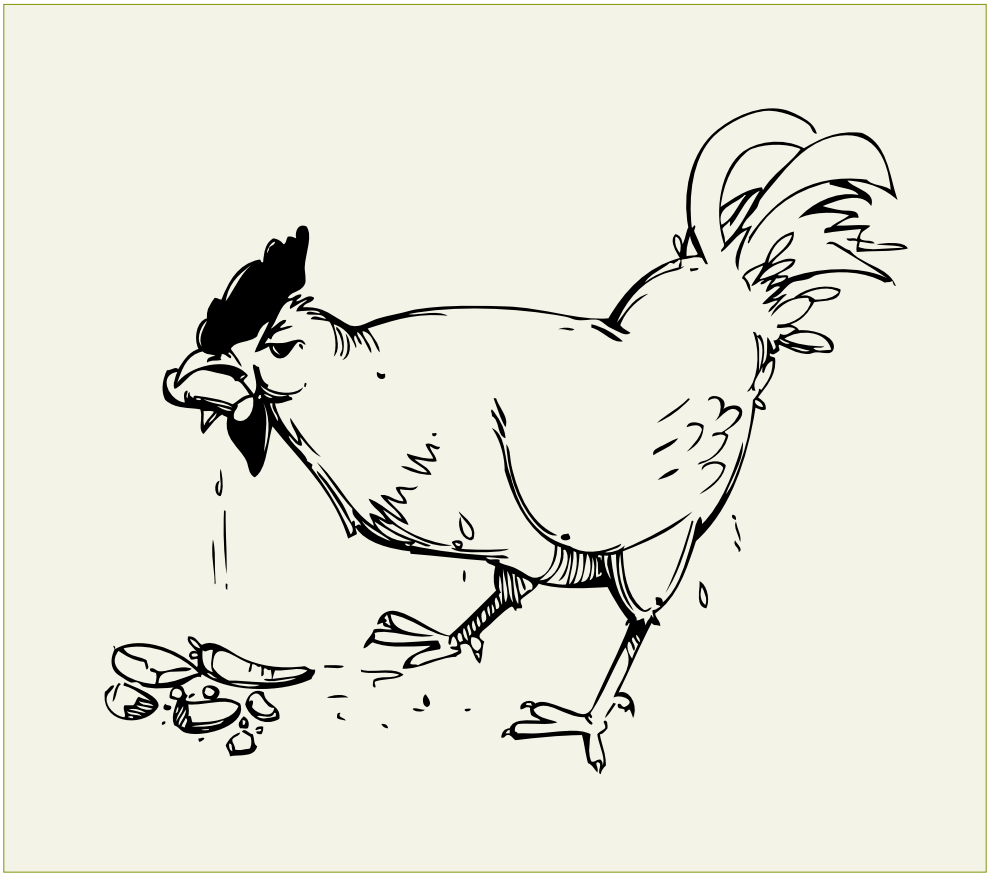

Figure 10. Birds have no teeth and so have difficulty eating large pieces of feed.

Sources of carbohydrates

The main sources carbohydrates will be cereals such as rice, maize, millet, sorghum and cassava. However, as far as possible, chickens should not compete with humans for food. If the family's own cereal needs have been met, a small area of rice, millet or sorghum could also be grown for animal feed.

Sources of proteins

Earthworms, and insects such as termites and cockroaches, are good sources of proteins. Their presence in chicken-scavenging areas can be encouraged in various ways:

- Maize bran mixed with enough water to make it gluggy will attract insects.
- Branches, grass and rubbish collected into heaps on the ground will be colonised by various types of insects. As required, a heap can be turned over and the chickens allowed to scavenge for the insects underneath. If a number of heaps are made, one heap of material can be made available for the chickens every few days.
- Branches and plants that attract termites can also be put into heaps and used in a similar way.
- If any cows are owned by the family, cow dung can be heaped to attract insects.
- Discarding dishwashing water and other waste water on an area of earth will moisten the soil and attract earthworms, especially in dry weather.

Plants such as leucaena can be grown as another source of proteins. Their leaves can be supplied to chickens fresh, or dried and crushed.

Sources of vitamins and minerals

Eggshells and bones can be roasted and crushed to provide a range of vitamins and minerals. It is important to roast and crush eggshells so that the chickens do not acquire a taste for fresh eggshell.

5.6.2 Cafeteria approach to supplementary feeding

In the 'cafeteria' approach, separate plates of feeds that provide concentrated sources of proteins, carbohydrates and minerals so that the chickens can choose the type of feed they most need (Figure 11). It is desirable to provide the feedstuffs in the approximate proportion that they are required. To optimise this approach, the approximate composition of the SFRB needs to be known (i.e. is it energy or protein deficient?) as do the composition and palatability of the feedstuffs provided. Where the protein supplement on offer is both reasonably palatable and well balanced in terms of amino acids, it should be sufficient to provide a grain (wheat or maize), the protein supplement and a source of calcium.

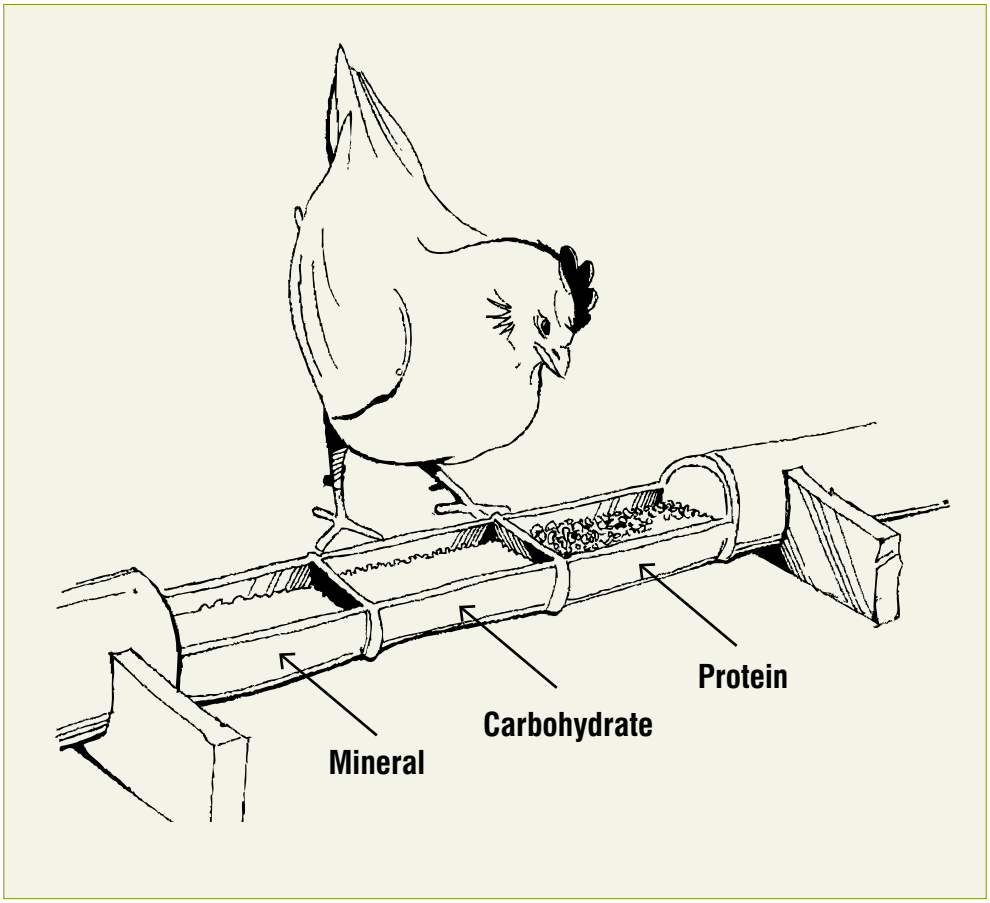

Figure 11. **Bamboo can be used to make a feed trough to provide proteins, carbohydrates and minerals in a cafeteria style.**

5.7 Feedstuffs that might be offered to chickens, and their nutrient content

Table 5 lists feedstuffs that can be used for supplementary feeding of chickens. Nutrient contents are given in relative terms only, since their absolute values might vary according to methods of preparation or processing employed. The list is not complete.

5.8 Feeding confined chickens

In general, confining chickens for long periods is not recommended under village conditions. Most villages do not have access to a regular supply of commercial chicken feed or, if they do, the cost of this feed exceeds the returns and increases the risks of raising village chickens.

Nevertheless, it may sometimes be necessary to confine some or all of the flock and, in such instances, providing a commercial chicken feed could be an option. Confined birds need to be fed a balanced diet since they are not able

Table 5. Feedstuffs that can be used to provide supplementary feed for chickens, and their relative nutrient contents

Feed	Carbohydrates	Proteins	Fats	Minerals	Vitamins
Barley	+++	+	+	+	+
Beans	+++	+++	+	+	++
Bones	–	–	–	+++	–
Clover	+	+	+	+	++
Eggshells	–	–	–	+++	–
Fats of animal origin	–	–	+++	–	–
Fish	+	+++	++	+++	+++
Fruit	+	+	+	+++	+++
Grass	+	+	+	+	++
Groundnuts	++	+++	+++	+	+
Insects	++	+++	++	+++	+++
Insect larvae	++	+++	++	+++	++
Lupins	+	+++	+	+	++
Maize	+++	+	+	+	+
Millet	+++	+	+	+	+
Oats	+++	+	+	+	+
Peas	+++	+++	+	+	++
Plant oil	–	–	+++	–	–
Potatoes	+++	+	–	+	+
Rapeseed	++	+++	+	++	++
Rice	+++	+	+	+	+
Rye	+++	+	–	+	+
Snail shells	–	–	–	+++	–
Sorghum grain	+++	+	+	+	+
Soybeans[a]	++	+++	+++	+	++
Sunflower seed	+	+++	+	++	+
Termites	++	+++	++	+++	+++
Tree and plant leaves	+	+	–	+++	+++
Wheat	+++	++	+	++	+
Worms	++	+++	++	+++	+++

a Soybean feeds for chickens are heat treated to inactivate inhibitors. Untreated soybean feeds can be poisonous to chickens.

+++ high content
++ medium content
+ low content
– none

to satisfy their needs by scavenging. Any imbalance or mistake in the ration offered will lead to a drop in productivity and perhaps disease and death of the birds. Birds should be given the diet appropriate for their age and stage of production: layers should not be given chick or grower diets, and chicks and growers should not be given layer diets.

If a reliable source of commercial feed cannot be obtained, or if the cost of this feed is too high, then a feed ration can be made at home. Care needs to be taken to produce a balanced ration. Feed could also be offered cafeteria style, as described in Section 5.6.2.

Another point to consider is that chickens need a few days to become accustomed to any new diet. When changing from a scavenging diet to commercial or other supplied feed, or vice versa, the ration should be changed gradually by offering a mixture of the existing and the new feed for some days.

Some advice on providing feed to confined chickens

- If possible, offer commercial feed to confined chickens.
- The most important group of birds to offer supplementary feeding to is young chicks from hatch until about 2 weeks of age.
- A village-type hen needs about 75 g of commercial layer feed per day (1 kg per 13 hens per day). Commercial layers require approximately 100 g/day.
- Buy feed that is designed for the type of birds held (e.g. chick starter for young layer or indigenous breed chicks to 6 weeks of age, layer mash for laying hens and, depending on their age, starter or grower broiler mash for broilers).
- Do not abruptly change the type of feed provided.
- Provide fresh feed daily to avoid contamination and spoiling.
- The trough must be big (long) enough to allow all chickens to feed at the same time. If the trough is too small, weak birds that are low in the pecking order might be pushed away.
- Prevent birds from sitting in or scratching in the trough. The trough should have a lip as well as a wire mesh grid to prevent food spillage. The food is expensive and waste should be kept to a minimum.
- Full troughs lead to spilt feed.
- Clean the trough regularly.
- Offer fresh water to the chickens daily.
- Store chicken feed safely away from rodents and wild birds to avoid losses and contamination. (Rodents and wild birds might carry infectious diseases.)

6 Flock management

6.1 Keeping the flock healthy and productive

Every chicken farmer aims to keep their chickens healthy and productive, to benefit from the flock in terms of meat and egg production. One major step towards increased productivity is to vaccinate against ND, the most devastating disease of chickens in many regions. Other diseases can also be controlled or limited in their effects (see Part 3) and improved housing (Chapter 4) and nutrition (Chapter 5) will help keep the chickens in good condition. The benefits from these actions can be augmented by good flock management.

Flock management aims to maintain a healthy and productive chicken flock throughout the year by choosing an adequate flock size and taking off any surplus in a way that is most beneficial to the chicken owner. Flock management also includes control of breeding and egg production to increase the output of eggs and chicks per hen.

Village chicken production is characterised by low inputs and outputs, many farmers selling or eating their chickens only when the need arises. However, once ND vaccination is implemented and/or other killer diseases are controlled, more chickens will survive. Consequently, the following possibilities emerge: 1. the breeder flock size can be allowed to increase; 2. surplus chickens surviving can be marketed or consumed prior to maturity; 3. fewer eggs can be set under the hens, allowing more eggs to be consumed or sold; 4. various combinations of 1–3. The scavenging feed resource base (see sections 2.4 and 5.2) will probably not support a significant increase in flock size within a village (1. and 2. above), which means that farmers will need to plan and manage their flocks more carefully. Good planning and management will help to maximise the benefits of increased chicken production and minimise any other problems that may arise once ND is controlled.

Farmers need to **plan well in advance** to get as much benefit as possible from their vaccinated flocks.

Possible negative effects that may occur once ND and other killer diseases are controlled include that:

- an increasing number of chickens might not find enough feed in the local environment
- other diseases (e.g. fowl pox) might become more prominent and important
- the supply of chickens and eggs to local markets may increase, resulting in a drop in prices received.

Extension staff can assist farmers to plan and manage their chicken production so as to minimise the above effects.

Case study

In the Mtwara Region in southern Tanzania a successful ND vaccination program has resulted in the price of village chickens increasing in the markets. Whereas previously farmers would sell their chickens at any price before an expected outbreak of ND, they are now more confident that their birds will survive. Farmers have become reluctant to sell their birds and are asking and obtaining a higher price from traders. The traders can also be more confident that the birds they purchase will not die from ND before they get them to market.

6.2 Flock size

Encouraged by the benefits of successful ND vaccination, farmers may be tempted to expand flock size. Farmers must consider the available feed resources (and the cost of supplemental feed if required), the family work capacity and the stocking density before making a decision. They should ask themselves the following questions:

- Will all chickens find sufficient nourishment from the feed in the surrounding area? (Be aware that many other farmers may be increasing their flocks at the same time.)
- Does the person who is looking after the chickens have enough time to take care of a larger number of birds?
- Is the chicken house, or the place where the birds are kept at night, big enough for the whole flock?

6.2.1 Feed resources

'Feed resources' refers to the feed available for scavenging around the house and village. In scavenging systems the feed resource must therefore be considered as probably the most significant constraint to expansion of chicken flocks once ND is under control (see Section 5.5)

6.2.2 Family work capacity

This manual contains suggestions for a range of possible interventions to improve the productivity of chicken flocks. Most of these interventions require at least a little extra labour (e.g. cleaning the chicken house, providing nests, feeding young chicks, treating hens for external parasites etc.). When the flock size increases, the time consumed by these activities will also increase. When a family considers keeping more chickens, they should make sure that there is a family member who will be responsible for the chickens and who has enough time to look after them properly. **A small chicken flock that is carefully looked after will bring more benefits to its owners than a big flock that is neglected.**

6.2.3 Stocking density

A high stocking density is likely to cause problems in a chicken flock. Chickens will fight more often to establish their ranking within the flock and they will compete for all resources (such as feed, water, nests and sleeping places). Infectious diseases might also spread easier and faster within a crowded chicken flock. Conditions related to poor husbandry or nutrition are also likely to be aggravated with an increasing number of chickens. For example, the amount of droppings (i.e. manure) increases with chicken numbers. Increasing quantities of droppings in the chicken house can increase the risk of transmission of parasitic worms and coccidia. Excessive amounts of moist droppings can also cause 'bad air' in the chicken house, which promotes the development of respiratory diseases.

If the flock size is increased, a farmer should ensure that:

- there is enough space in the chicken house for all birds
- there are enough nests for all hens
- all chickens can feed at once if supplementary feed is provided
- someone can remove droppings regularly from inside and below the chicken house
- there are not too many roosters (to avoid fighting).

A farmer would be well advised to increase flock size only gradually as they gain experience in managing and feeding the birds. Given the limitations of the SFRB, especially in low-rainfall areas or during the dry seasons, farmers should be encouraged to maintain a nucleus flock of not more than 15–20 adult breeding birds (the actual number will depend on local conditions). Even if supplementary feed is available, they should, rather than build up large flocks, eat or sell the surplus eggs or chickens of inferior breeding quality. Neighbours should also be encouraged to keep smaller flocks so that the feed available in the village can be shared equitably.

6.3 General hygiene

The saying that 'Prevention is better than cure' is very appropriate. Although there are limited possibilities to improve chicken hygiene under rural village conditions, being aware of the need to maintain general cleanliness for chickens will certainly help. Here are a few procedures that farmers should find easy to carry out:

- Clean the chicken house regularly, both inside and outside. Remove droppings and rubbish and replace worn and dirty perches when necessary.
- Put ash on the floor and treat the wooden parts with old engine oil to help reduce the number of external parasites. For the same reason, fumigating the chicken house with smoke two or three times a year is a good practice. If lime-wash is available, the walls can be painted with it.

- Bury or burn birds that die, otherwise they remain a source of infection for healthy birds. If there is a good pit latrine, not yet too full, dead birds can be disposed of by throwing them into it.
- Kill and bury chickens that appear very sick, so that they do not infect others. If many birds in the flock have been sick and died, the old chicken house should be burnt and a new one built on a different site.
- Do not immediately return to the family flock chickens that have been sent away to market and have not sold. They may well have come into contact with disease-carrying birds. If they cannot be killed and eaten, they should be isolated for at least 14 days before they are returned to the flock.
- Be on the lookout for traditional, local treatments for chickens. As most rural people know, many plants have medicinal value. Some local remedies that are used to treat humans could also be effective for chickens. For example, medicines used to treat intestinal worms in children will probably have the same effect in chickens—at least they could be tried out on a small sample first.
- Use locally available plants that have been shown to assist in lowering infestations of external parasites (lice, fleas, mites, ticks).
- Work with other poultry farmers in the community to encourage hygienic practices throughout the village. As village poultry can roam throughout the village, the best way to have healthy birds is to make the village environment a healthy one.
- Do not introduce new birds into a flock when there is active disease in the village or surrounding area.
- Keep all new birds separated for 14 days before allowing them to mix with the existing flock.

6.4 Laying, brooding and hatching

Proper management of laying hens will improve their productivity through increases in egg production and the number of clutches per year, and in the hatching rate.

6.4.1 Laying hens

In villages, hens start to lay eggs when they are about 5–6 months of age. Malnutrition or poor health condition in growers will result in the birds coming into lay later and producing fewer eggs.

In uncontrolled conditions (i.e. no active management), a hen lays about 10–15 eggs, usually on consecutive days (called a clutch), before she becomes broody and sits on the eggs to incubate them. After about 21 days she will hatch out an average of 8–12 chicks. She then repeats this, on average, three or four times a year.

Not all eggs laid are necessary for producing future generations. Some hens may lay 20 or more eggs in a clutch, but a small village hen cannot adequately cover so many eggs, and can only properly look after a maximum of 8–10 chicks (especially in colder weather or when the SFRB is poor). A hen may also abandon her nest with all the eggs in it. This is a waste of a very valuable protein or income source for the family. In addition, eggs left in nests are repeatedly being heated and cooled as hens leave and return daily to lay more eggs. This can cause early embryo mortality.

One simple intervention is to collect eggs from the nests at least twice a day (preferably when no hen is on the nest). Always leave at least one egg in the nest to encourage the hen to continue using that nest. By taking eggs from a hen that is not yet brooding, you will stimulate the hen to produce more eggs, as the hen will always try to complete the clutch before starting to brood. If a hen is eating well, she may lay as many as 25 eggs before becoming broody.

Good-quality eggs for brooding

Some farmers may wish to have more control over the quality of eggs. If so, the following procedure could be adopted. All eggs laid on a particular day could be marked with a letter or number (e.g. 1 for Sunday, 2 for Monday etc.) or the date (including the eggs that are left on the nest). Thus, the farmer will know which eggs are the freshest. The most recently laid one or two eggs should be left in the nest each day to encourage the hens to continue laying. Once a hen becomes broody, and if the owner wants her to produce chicks, a number of fresh, fertile eggs can be selected from those in storage and placed under the broody hen (see Section 6.4.2).

Some people believe that taking eggs from the nest may cause a hen to abandon it—this may occur, but is rare. If the farmer is removing several eggs from a nest that already has a good number present, especially when the hen is broody and sitting, this should be done in the evening when it is dark. It may also help to dust your hands with wood ash before collecting eggs so as not to leave a human smell on the eggs.

If a farmer has a problem with hens laying their eggs in remote, inaccessible nests, they should keep the hens in their house with nests for a few days for part of the morning (until about 10 or 11 o'clock) to help break this habit, as most eggs are laid before midday.

Laying hens can be identified in the following ways:

- Check the width of the bones around the vent (Figure 12). With non-laying birds, only one finger can be placed between the two pubic or 'pin' bones and two fingers between the pin and breast bones. Laying hens can have a space of two to three fingers between the pin bones and four to five fingers between the pin and breast bones—depending on the size of the chickens and size of your fingers.

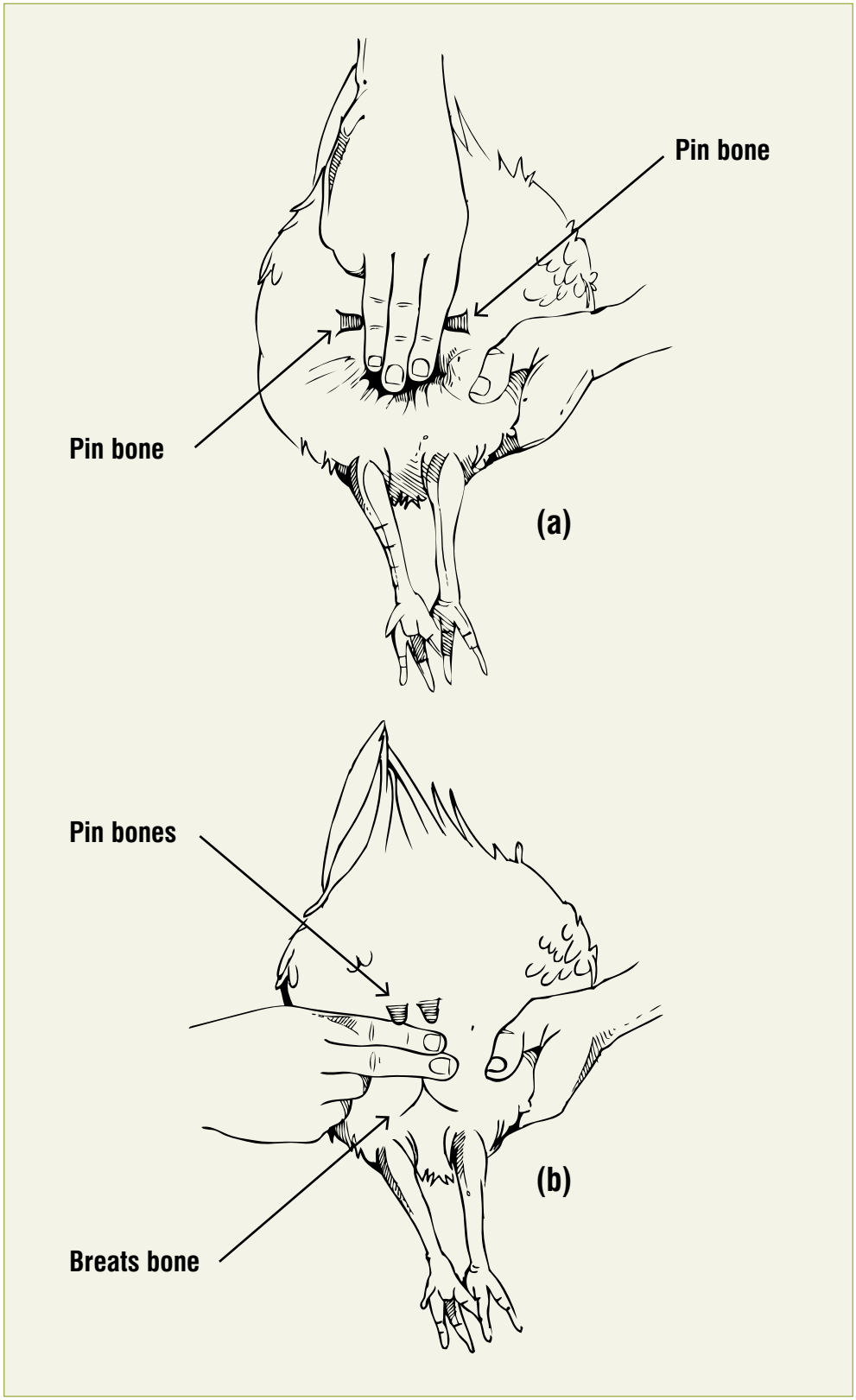

Figure 12. Two to three fingers can be placed between the pin bones on laying hens (a); in non-laying birds, only two fingers can be placed between the pin and breast bones (b).

- Look at the comb. Adult hens with a very small and pale comb are not in lay and are probably either moulting or in poor health. If hens in poor health do not recover they should be separated from the flock, since they are not productive and may transmit disease to the healthy birds. A small, pale comb is normal in moulting birds.
- Look at the vent. A non-laying hen has a puckered vent while a layer has a large, oval, moist and bleached vent.

The following are some other steps that farmers can take in looking after laying hens:

- To ensure a high fertility rate in eggs, a flock should have one rooster for every 10–15 hens, plus one extra rooster in the flock in case the other gets hurt or dies. So if a farmer has 10 hens then there should be two males, and if they have 20 hens, they should keep three (not four) roosters. If there are too many roosters, they will fight and fertility will not improve. If an egg has not been fertilised by a rooster, then no chick will hatch (Figure 13).

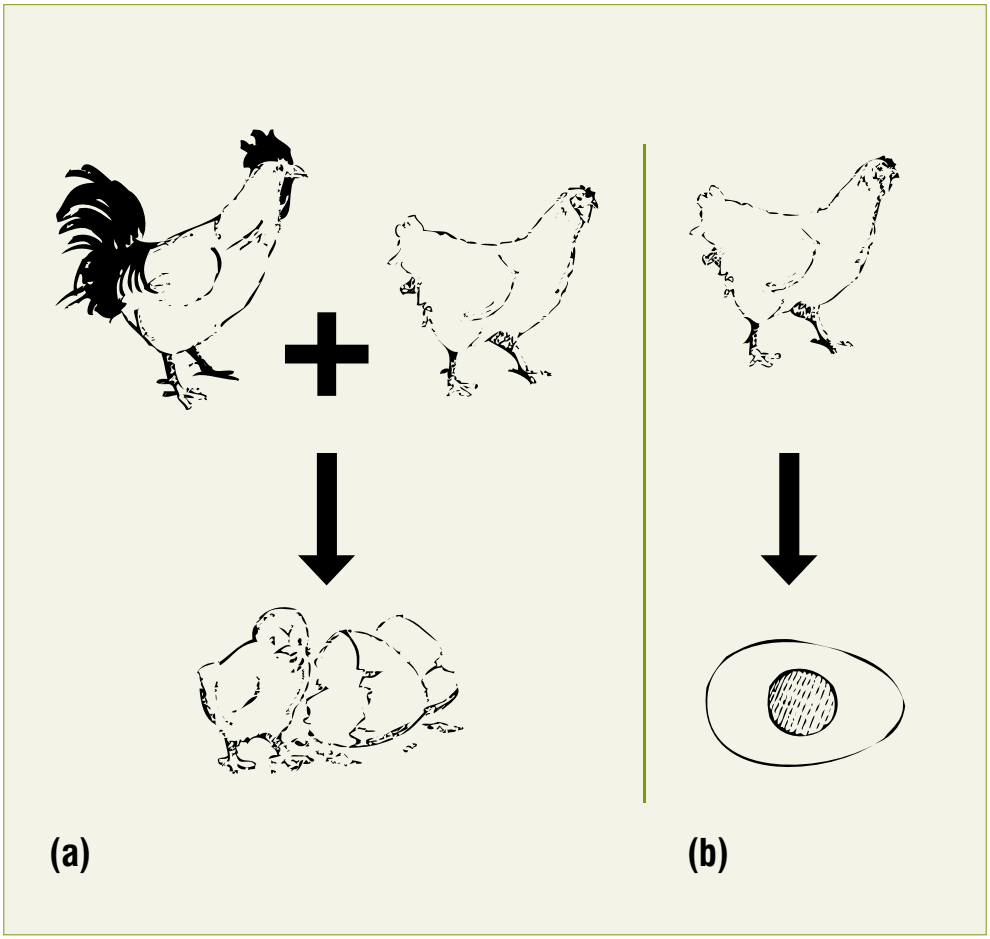

Figure 13. A chick is produced when a hen has mated with a rooster before laying the egg (a). If the hen has not mated with a rooster, then the egg will not develop into a chick (b).

- When a hen is about to lay, she looks for a quiet, safe and dark place to lay the eggs. Hens tend to lay their eggs in places where there are already eggs. For this reason, several hens sometimes use one 'community' nest;
- It is advisable to provide sufficient nests for all hens in a flock, to avoid hens choosing places for nesting where the eggs cannot be found, are exposed to bad weather, or are easily accessible to predators (see Section 4.6).
- Eggs that are removed from the original nest chosen by the hen and then placed in another nest may be rejected by the hen.
- Hens lay the most eggs during their first year in production. Thereafter, production decreases rapidly, especially after the second year of age. Thus, to ensure a high level of egg production in a flock, hens should not be kept for longer than 2 years.
- Identify the hens that produce many eggs. Also, watch how well they sit on their eggs and how well they raise their chicks. This will help the farmer to choose which hens make the best mothers. Keep the pullets produced by hens which are good layers and which show good mothering ability as replacement stock.
- It is important for farmers to observe their hens and note which are the better layers. The ones that lay few or no eggs should be culled (i.e. eaten or sold).

Under village conditions, a hen produces 3–4 clutches per year on average. Laying eggs takes about 2 weeks and brooding another 3 weeks. The hen will then take care of her chicks for about 8–12 weeks before she starts to lay eggs again. If feed availability and predation are not a concern, chicks can be separated from hens at around 6 weeks of age to encourage the hen to come back into lay more quickly.

6.4.2 Brooding and hatching

Once a clutch of eggs is laid, village hens usually become broody. (They sit on the nests for most of the day and may even sleep there. They are aggressive and make a characteristic squawk when approached.) A broody hen will incubate the eggs and then look after the chicks that hatch. She sits on the eggs for 21 days, leaving the nest for only short periods to get feed and water.

A hen can lose a lot of weight while she is incubating the eggs. Ensure that water and some supplementary feed are nearby to minimise this effect. Since she has depleted her calcium reserves to lay the clutch of eggs, it is important to also provide her with a good source of calcium during this period to build up her bones and to encourage her to commence laying as soon as possible after rearing her chicks. If the hen has to leave the nest for long periods to look for feed and water, the eggs may cool down excessively, resulting in poor hatchability and chick survival.

To test that the hen is definitely broody and will not abandon the nest, the farmer can put two or three old eggs under her. If she stays on the nest for 2 or 3 days, it indicates that she is truly broody. The old eggs can then be taken away in the evening when it is dark and replaced with 8–12 of the fresh, stored eggs. Very small or very large eggs should not be set—choose well-shaped, strong-shelled eggs. Do not set eggs from very young hens, as these usually do not hatch well.

The farmer should control the number of hens that are allowed to hatch eggs at any one time. The most favourable time is when there is more feed available for the hen and her chicks (harvest time or when the SFRB is rich) and when the weather is not too hot or too cold. It should also be taken into account that in some areas the hens lay eggs and go broody only at certain times of the year.

If the farmer does not want a broody hen to hatch eggs she can be placed in a small, separate cage in a cool, shady place. Keep the cage off the ground and cover the floor with wire or small branches to allow good air circulation. Make sure the hen has water and feed. In a few days she will lose her broodiness and after a while will start laying again.

If possible, it is good practice to separate a broody hen from other birds so that she is not disturbed while incubating her eggs. However, if this means that the nest must be moved, it may well lead to the hen abandoning the nest. So the move needs to be done carefully, preferably at night.

After 21 days of brooding, the chicks will hatch. Note the following points at hatching:

- Do not disturb a hen during hatching, because low temperature and/or low humidity have a negative effect on the hatching rate.
- Discard the eggs if a hen has been sitting on them for longer than 21 days. To make sure that the eggs do not contain living embryos, they are best candled before discarding (see Section 6.4.3)
- Hatching might take longer if the hen cannot completely cover all the eggs with her body, or when the clutch consists of eggs from different hens. In this case, the hen may abandon the eggs that are not already hatched to look after the newly hatched chicks. If an owner is concerned about this, they could remove dry chicks from the hen and keep them in a warm and safe place until the evening, when all of the chicks have hatched.

6.4.3 Candling eggs

Candling will provide information on whether an embryo is developing inside the fertilised egg and whether this embryo is alive. To check whether a chick is developing inside an egg you can hold the egg in front of a bright light (e.g. a paraffin lamp, a candle, a torch or a light bulb; Figure 14) inside a dark room. Candling can be done at about day 6–8 after a hen has started brooding a clutch to determine fertility and once again around day 17–18 to identify viable eggs and those containing dead embryos or bacterial rots. Eggs containing

bacterial rots and dead embryos should be discarded as they are a potential source of infection for the hatching chicks. White eggs are easier to examine than brown eggs.

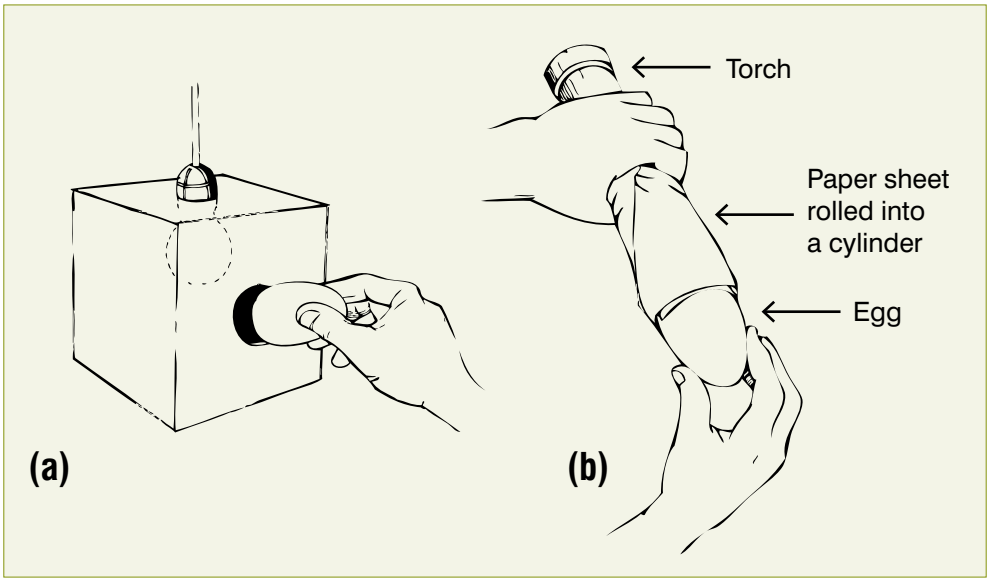

Figure 14. Eggs can be candled using a lamp (a) or a torch with a paper funnel adjusted to give a tight fit around the egg (b).

At 6–8 days you can see the shadow of the embryo, which might move in response to the light, as well as a fine net of blood vessels (Figure 15a). Eggs in which no embryo is developing are completely clear and may be removed and used for cooking. (Place the eggs in water first to ensure that they are not bad—good eggs will remain on the bottom of the container while bad eggs will float). In a fertile egg after 9–10 days of incubation (Figure 15a and b), the clear air cell in the blunt end of the egg takes up about one quarter of the volume of the egg, and the embryo, its membranes and fluids fill the remainder of the egg, allowing almost no light to pass through. There is a clear line separating the embryo etc. from the air cell.

Development of a chick inside the egg

Within 2 days of brooding the head and body of the embryo form. Fine blood vessels can be seen when candling the egg. From day 3, the chick's heart starts to beat. By day 7 of brooding, feathers, beak, head and stomach can be seen on the **embryo** (Figure 15a and b). At day 15, only a little **albumen** remains inside the egg and the plumage is complete. By day 19, the chick and the remaining **yolk** fill the egg completely. Shortly before hatching, the egg yolk is pulled into the chicks' abdomen via the navel to form the 'yolk sac'. The chick then starts to pick the eggshell just below the air cell using the 'beak tooth' which looks like a small thorn on the tip of its top beak.

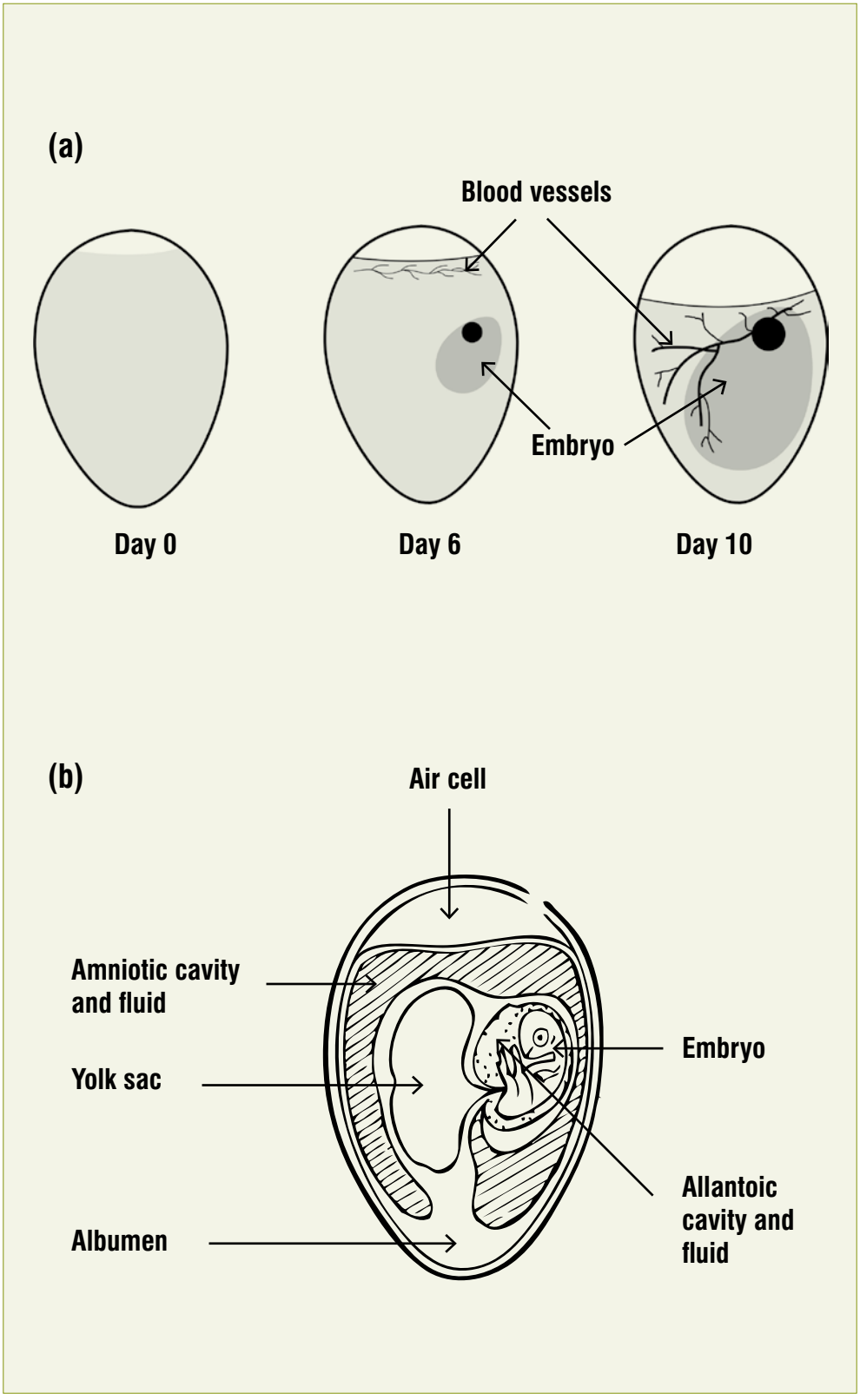

Figure 15. Drawings of a chick embryo developing inside an egg. The illustrations in (a) represent the development of embryos from day 0 to day 6 and day 10, as seen when candling an egg. The embryo in (b) has been developing for approximately 9 days.

6.5 Raising young chicks

Newcastle disease is a major cause of chick mortality, but chicks are also the age group most vulnerable to other diseases, predators, and environmental and nutritional problems. Although the local breeds of chicken are much better at mothering their chicks than exotic breeds, there are still many situations in a village that are beyond the mother hen's control. For this reason, newly hatched chicks need special care during their first 4–5 weeks of life. If extra care is given for these first few weeks, then there is a much greater chance that the birds will survive and grow into healthy, productive adults.

6.5.1 Feeding and nutrition

Young chicks have a limited ability to scavenge for feed and they can expend a large amount of energy just to find enough feed to survive. However, confinement of chicks for 2–6 weeks can be costly and labour intensive. An alternative is to provide a small amount of supplementary feed to young chicks and allow them to scavenge for most of the day with the hen.

To provide extra water or supplementary feed specifically for young chicks, a small enclosure that chicks but not adults can enter, can be used for feeding. This is called 'creep feeding' (Figure 16).

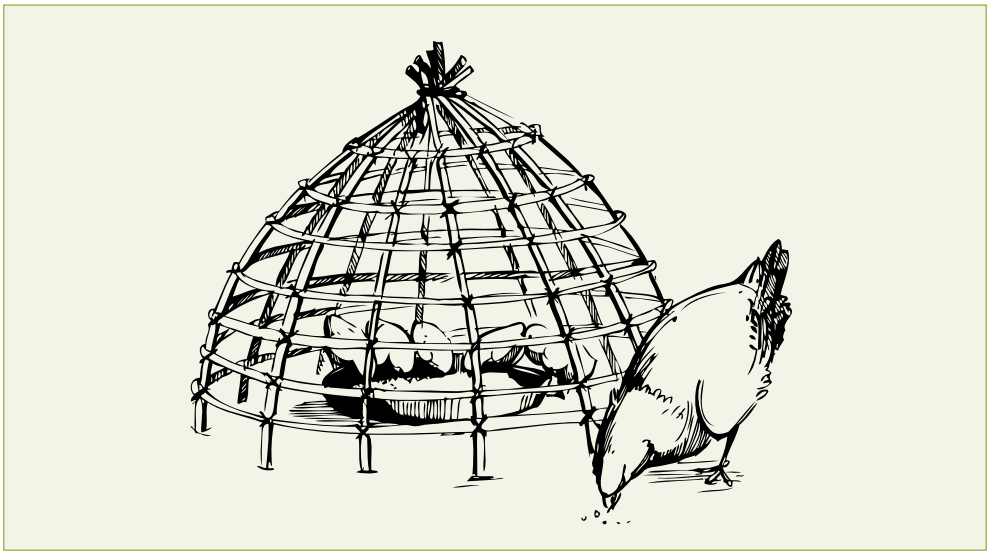

Figure 16. A creep feeder can provide a small quantity of feed specifically for chicks and not adult birds. This is useful when the quantity of feed available is limited. Clean water should also be readily available.

Clean, fresh water should be provided in a trough appropriate for young chicks (Figure 17). The trough should be low enough for the chicks to drink the water easily without getting wet or drowning, and have a broad base to prevent it from being tipped over. Pebbles may be placed in the trough when the chicks are very small.

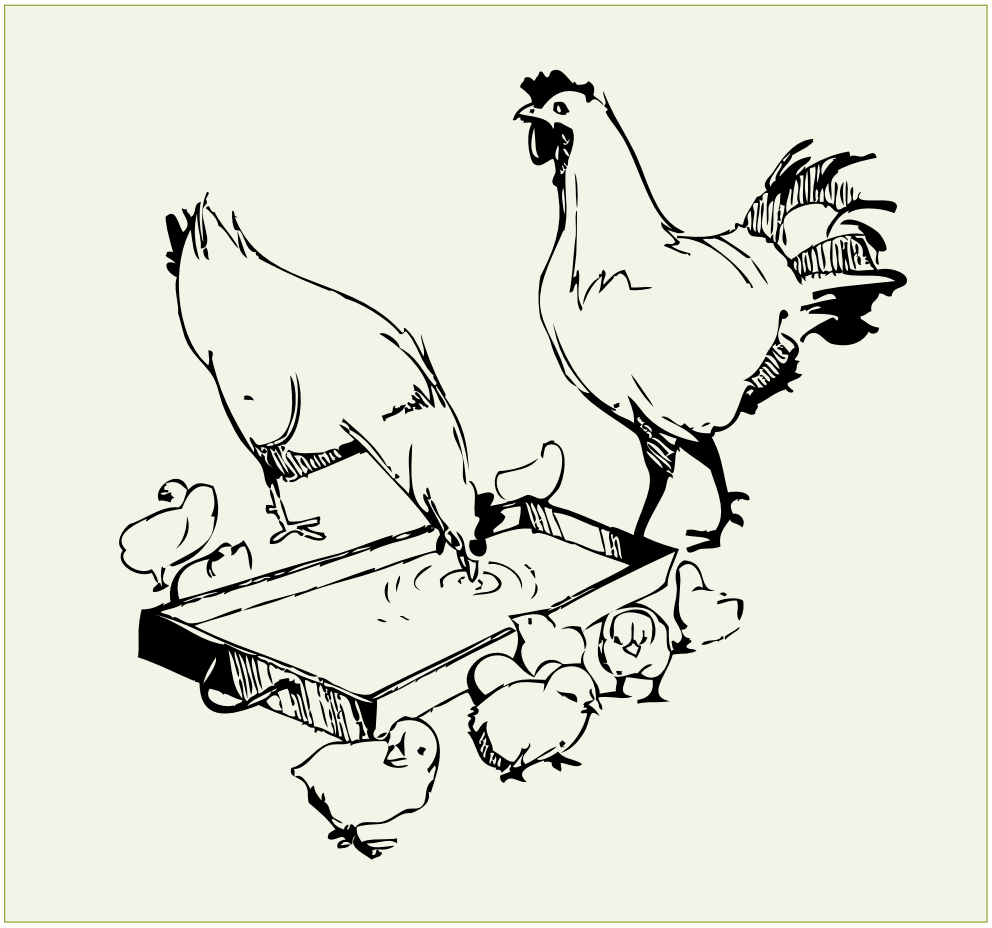

Figure 17. **A low, shallow water trough containing a small volume of fresh water is appropriate for both chicks and adult birds.**

What can be offered to young chicks for supplementary feeding?

A range of feedstuffs available from village resources can be used to supplement the diet of young chicks. Such feedstuffs include leftover food, maize meal, maize (corn), rice, cereals, green leaves, worms, and a range of insects and their larvae. In addition, it may be possible to utilise materials such as dried leaves from shrub legumes, cowpeas or pigeon peas, which could be specifically planted around houses. If available, a hard-boiled egg chopped into small pieces can also be offered to very young chicks.

Maize, rice and other grains should be crushed or pounded before being offered to young chicks, to enhance their digestibility. Soaking crushed maize in water for a short time before offering it to chicks will also enhance its digestibility.

If a farmer is reluctant to provide grains that could otherwise be used by the family, then the bran left over after milling could be given. Bran is not an ideal supplement for chicks, however, because it has a high fibre content and only moderate levels of proteins and energy. Young chicks have very limited capacity to cope with high-fibre feedstuffs.

What feed should be given to confined chicks?

If the chicks are confined for the first 2–3 weeks, their diet should contain an appropriate mixture of energy, proteins, vitamins and minerals (see Chapter 5—Nutrition), such as maize bran, crushed maize or wheat **plus** shrub legumes, fruit or any other green feed. This diet can be enriched with protein by offering termites or other insects to the chicks. A hard-boiled egg chopped into small pieces might also be added to the ration from time to time. The overall diet should contain more than 20% proteins and, because of limitations as to how much birds can physically ingest, the energy level should also be moderately high (>11.7 megajoules of metabolisable energy per kg).

Chicks may be fed household leftovers but problems may occur if the feed contains too much salt (sodium chloride). High levels of salt will result in watery droppings. The overall diet should not contain more than about 0.3% salt.

If commercial feed is available and affordable, small quantities can be provided to avoid malnutrition in young birds, including those that scavenge with the hen for all or part of the day. One kilogram of a good-quality commercial chick starter feed will be enough to feed a clutch of 10 chicks for the first 10–12 days of life. If feed is bought for chicks it should be especially designed for this age group. Do not feed layer mash to young chicks, because the nutritional needs of laying hens differ greatly from the needs of young chicks that still have to grow. If commercial feed is provided to give young chicks a good start, do not change the diet abruptly. Mix the feed they have been eating for a few days with the feed they are to be offered in future, to allow the chicks' digestive systems time to adapt and also to accommodate differences in palatability. Otherwise they may stop eating, or the new feed may cause diarrhoea.

Remember to always provide clean water to confined chicks.

When confining chicks remember:

- Confined chicks need to be fed a balanced diet daily.
- Chicks in free-range systems need their mother hen to teach them how to survive. If chicks are confined to protect them during their first days of life, the mother hen should be confined with them. For the chicks to learn scavenging, the whole family should be set free after no longer than 2 weeks confinement.
- After being confined for some time, chicks need supplementary feeding for a few more days until they have learnt how to survive from scavenging. This can be supplied through creep feeding.

6.5.2 Protection from diseases

The following steps should be taken to minimise exposure of chicks to diseases:

- Nests should be cleaned before or after each clutch to minimise the risk of infection.
- Brooding hens should be treated against fleas and other external parasites, to avoid infestation of newly hatched chicks (see Section 11.6).
- Blood-sucking external parasites are very harmful to young chicks, which should be regularly checked for infestation with external parasites (especially fleas and mites) and treated as soon as an infestation is noticed.
- If possible, hens with young chicks should be housed separately from the flock (especially where elevated houses prevent chicks from entering). Avoiding close contact with other birds by keeping them separate overnight also decreases the risk of infectious diseases that might spread from the older chickens to the young chicks.
- Prevent chicks from scavenging in places where there are many droppings from adult chickens. These droppings might contain coccidia, which can cause severe disease in the chicks (see Section 11.4).
- Since nutritional, environmental and other factors (see Figure 22 in Chapter 8) directly affect the chicken's health status, good husbandry is especially important for young chicks, which are not used to coping with harsh conditions.

6.5.3 Protection from predators

The best way to protect chicks from predators is to keep the young birds in a pen. However, this is not always practical in an extensive production system, because confined chickens need to be offered feed and water regularly.

- To decrease the risk of predation, extra feed and water can be provided for chicks near the home so that they do not roam too far. Offering feed under a roof or tree, for example, will help to hide young chicks from avian predators such as eagles and hawks.
- Hens with young chicks should be housed at night to protect the chicks and their mothers from predators and harsh conditions.
- Where chicks are confined, it is important to ensure that the house and/or cage is constructed in a way (see Chapter 4) that keeps out snakes, rodents and other predators. Internal feeders and waterers are preferable, and the spacing between the wire or bamboo slats on the cage is very important in preventing access by snakes and other predators.

6.6 Breeding

Although village chickens are not as productive as commercial chickens, ue to suboptimal housing, management and feeding, their genetic potential is rarely fully exploited. The village chicken is arguably the best bird for the conditions existing in rural villages and, in the vast majority of situations, it is not advisable to introduce exotic breeds at this stage (even if such are readily available). The productivity of indigenous chickens can be significantly improved over time by selecting only the healthiest males and females with the best production and conformation for breeding purposes. Using the existing chicken breeds and strains will also mean that they will retain their ability to survive under harsh conditions.

Remember that village chickens have many advantages over commercial birds. They are easiest to look after; are more resistant to many common diseases; can survive better under difficult conditions; know how to scavenge for their feed; are good at brooding, hatching and raising their young; and have better camouflage and capacity to escape predators (including the ability to fly).

Interbreeding between closely related birds can be avoided by obtaining, by purchase or exchange about once every 2 years, chickens (especially males) from more distant villages. The farmer should make sure there is no disease present in the chickens and should keep them isolated from the rest of the flock for at least 14 days after they are obtained.

It is important to maintain the correct mating ratios; that is, not have too many or too few males for the number of hens. The general guide is to have one rooster for every 10 hens, plus one extra rooster (in case one gets hurt or dies). So if a farmer has 10 hens, there should be two males, or if they have 20 hens, they should keep three roosters.

Breeding aims to increase productivity by using the best available genetic material to produce offspring. To achieve this, only birds that perform well should be allowed to mate, while other birds should be culled from the flock. When selecting birds for breeding, farmers should look for chickens that:

- are healthy and robust
- grow and produce well with the feed available
- have well-developed breast muscles (especially in roosters)
- have a deep, rounded body (especially in hens)
- are neither too big nor too small
- are confident and healthy (even showing signs of aggressiveness in the male)
- have lively eyes and a full, red, moist-looking comb
- are fast growing
- are good egg producers
- have a good hatching rate
- have good mothering skills.

Younger hens have better productive ability and fertility but birds that are more than 2 years old may still be used for breeding if they have desirable genetic characteristics. If the farmer wants to introduce the naked neck or frizzled feather genes into the flock, then male birds with these characteristics should be used. Naked neck and frizzled birds have been shown to be more tolerant of high temperatures. Birds showing any inherited disorder should be culled.

Different breeds of village chickens have been recognised in many countries. In Tanzania, for example, at least four distinct ecotypes/breeds have been recognised (Table 6), and in northern Laos, farmers also recognise four different types of local chickens—the large chicken (*gai yok*), the medium chicken (*gai lat*), the dwarf chicken (*gai jeh*) and the fighting cock (*gai tee*).

Table 6. Characteristics of different breeds of local chicken in Tanzania (Buza and Mwamuhehe 2001)

Breed/Type	Characteristics
Kuchi or *Kuza*	Short beak with few feathers; heavy with good meat; lays few eggs (7–10) per clutch; 4 months laying interval; mature size big; much preferred due to its size and weight
Poni or *Kishingo*	Small; lower weight; many feathers; lays up to 20 eggs per clutch; good mothering ability; 4 months laying interval
Mbuni	Moderately large; no tail; lays up to 15 eggs; laying interval 3–4 months; more vulnerable to diseases
Tongwe or *Msumbiji*	Short and stout; small and of low weight; lays about 20 eggs per clutch; good mothering ability; preferred by producers but not buyers because of small size; laying interval 3–4 months

6.6.1 Introduction of exotic breeds

In commercial chicken production systems, productivity is increased by introducing better-performing breeds. Some of these 'improved breeds' are also promoted for improving village chicken production. Before introducing these more productive birds into a village flock the following points should be considered:

- Low productivity of local breeds is related to poor nutritional and husbandry conditions as well as a lower genetic potential. Under optimal conditions, even village chickens will perform better.
- The harsh conditions of most village chicken production systems will not allow 'improved breeds' to perform as well as they would in commercial systems, even if they are afforded special care.
- Village chickens are adapted to harsh environmental conditions such as scavenging for feed, being exposed to various diseases, and hiding and flying to escape from predators. Exotic breeds have been developed for commercial systems and are accustomed to high-quality feed and regular health care. They are more susceptible to diseases and predators and are

not as good at scavenging for feed. Exotic breeds will therefore need more care than traditional breeds. They will need more supplementary feeding, provision of water and proper housing, and protection against predators.

- Commercial breeds are very likely to be more susceptible to local diseases, whereas village chickens, over the generations, have adapted to cope with a number of diseases and parasites.
- Commercial hens often make poor mothers. Many breeds do not go broody and hence will not sit on the nest to hatch eggs. After their chicks have hatched, the mother may not know how to teach them to scavenge for feed and may not care for the chicks.
- Better-performing birds are often sold as chicks from 1 day to 6 weeks of age. Young chicks are more vulnerable to poor conditions than are adult birds and more likely to suffer under them.
- Comparisons between the egg production of commercial layers and indigenous hens are often misrepresented by not accounting for the extended period of time that the village hen spends hatching the eggs and caring for the brood of chicks before she recommences laying.

For these reasons, if a farmer wishes to introduce exotic breeds into the flock they should consider the following suggestions:

- Do not buy young chicks unless you have experience in raising motherless chicks.
- Buy only healthy-looking birds.
- Determine if the birds have been sexed. There is little or no value in purchasing culled, layer strain male chicks.
- Ask the seller how the chickens have been kept (housing, feeding) and whether the birds have been vaccinated (especially against ND).
- Keep the new chickens separate from the village flock at first (for 14 days if possible) to prevent them from getting sick with any disease that might occur in the village flock and to confirm that the new birds are disease free.
- If chickens are used to being confined they will not know how to scavenge or protect themselves from predators. For this reason, newly acquired birds of commercial breeds have to gradually get used to the free-range system. They should be kept confined and fed commercial feed for 3 weeks before being allowed to move around in a fenced area and gradually given more locally produced supplementary feed. They can then be given longer periods of freedom to scavenge for feed over another 1–2 weeks. Interbreed the improved breeds with the local breeds as soon as possible, so as to gain some of the benefits of both breeds in the offspring. This needs to be done initially on a small number of birds to ensure that the resultant stock have desirable qualities and do not possess unwanted characteristics.

6.6.2 Meat production versus egg production

Purposeful breeding aims to get either more eggs or more meat. Big chickens with thick breast muscles often produce fewer eggs because they convert the feed into muscle rather than eggs. Similarly, good egg producers are usually smaller because they convert more feed into eggs rather than into muscle. The maintenance requirements of large birds are also greater than for small birds.

If breeding aims to increase egg production, more emphasis should be put on the reproductive and mothering performance of the hens, while breeding for meat production should focus mainly on characteristics of rapid growth and size.

If a farmer intends to 'improve' their flock with exotic breeds, they have to decide whether to introduce birds known for good egg production or for good meat production. However, some improved breeds are known as 'dual-purpose breeds', which means the birds are bigger than average (with more meat) and produce a good number of eggs as well. They do not grow quite as large as the purely meat breeds and do not produce quite as many eggs as the purely egg breeds, but are somewhere in between the two.

Whether or not exotic breeds are introduced, the farmer should be encouraged to always select the best birds for breeding within their flock and eat or sell chickens with low production.

6.7 Meat production (sale and consumption)

A healthy and productive chicken flock has the capacity to increase in numbers and allow the off-take of more birds for consumption, sale, barter and other purposes. Depending on the availability and cost of feed for the additional birds, chicken farmers should have more money available for essential household expenses, and will improve their family's diet by making more chicken meat and eggs available for consumption.

In certain areas, there are traditions restricting the consumption of chickens and eggs. These traditions may gradually change as production starts to improve. Extension staff can also assist by promoting the consumption of chicken meat and eggs. The nutritional value of chicken meat should be promoted, as well as the value of eating chickens and eggs for young children and pregnant and breastfeeding mothers.

Extension staff should collaborate with colleagues working on human nutrition within the ministries of health and education to raise the awareness of families about good eating practices and the contribution that chickens and eggs can make to good health.

6.7.1 Nutritional value of chicken meat

Meat from village chickens contains highly valuable proteins, vitamins and minerals, and relatively little fat. As a result of genotype and the scavenging

diet, the fat consists of over 60% unsaturated fatty acids and a relatively high proportion of omega-3 fatty acids, which are very beneficial in membrane formation in developing babies and children.

Why do we need proteins?

The human body constantly needs proteins. Each adult needs to consume 45–55 g of proteins daily. While absolute amounts depend on age and body weight, growing children and nursing mothers need a higher proportion of proteins in their diets.

Every cell of the body contains proteins. An adult's body contains about 12 kg of proteins. Furthermore, hormones and enzymes, which are necessary for all essential functions of our body, cannot exist and work without proteins.

This means NO life without proteins!

6.7.2 Selection of chickens for consumption or sale

When selecting chickens for consumption, sale, barter or other purposes, both optimal use of the available feed resources and breeding factors should be considered: **chickens that perform well should remain in the flock for further production and breeding while unproductive birds should be culled from the flock** (Figure 18). In this way, a farmer will not waste valuable feed resources on unproductive birds while at the same time the quality of the flock will gradually be improved.

The large, fast-growing chicks are usually the male birds. These are called cockerels and they are best eaten when they are young as only a few mature male birds are required for breeding.

When culling chickens from the flock, the following points should be considered:

- Cull cockerels for consumption or sale at about 4–5 months of age. Keep only the best cockerels for breeding.
- Sell or eat the hens that are not laying well.
- Sell or eat hens that are older than 2 years, as egg production and meat quality rapidly fall after this age.
- Keep female birds that lay and mother well for further production.
- Select the best-performing birds for breeding (see Section 6.6).

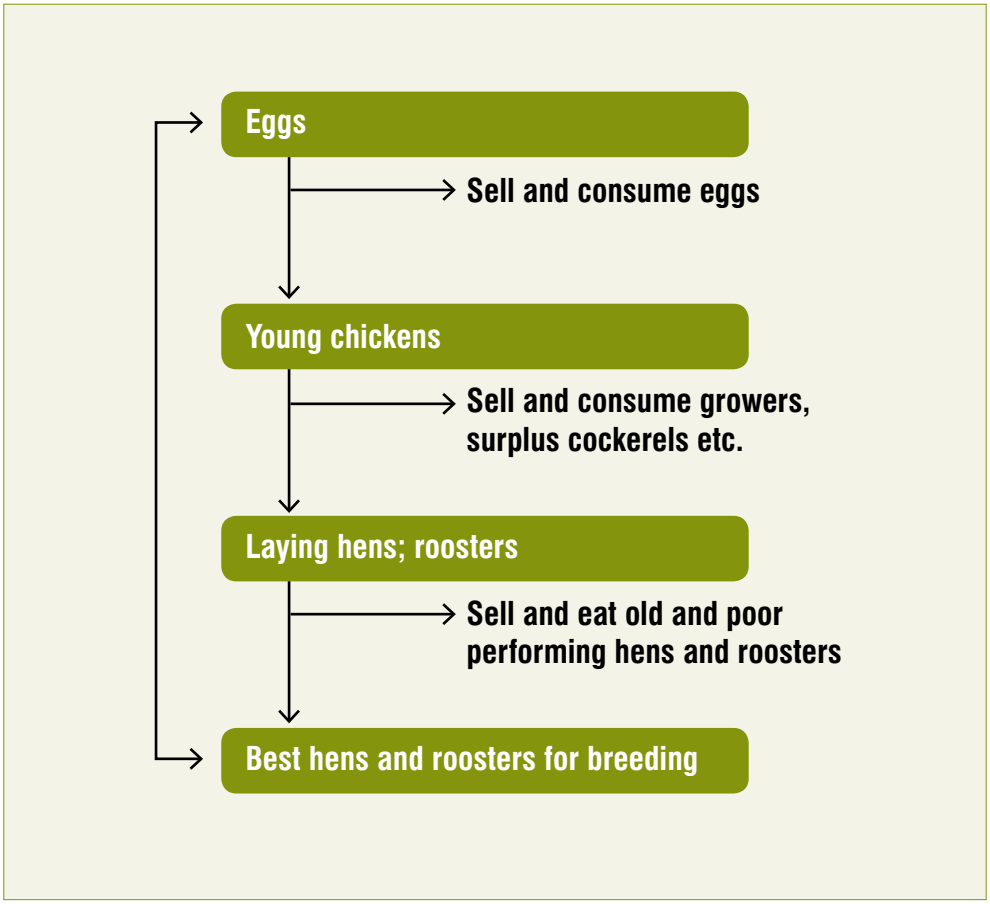

Figure 18. **The selection process required for improving a chicken flock**

6.7.3 Marketing surplus chickens

For many farmers, village chickens are a living bank account. The sale of chickens or eggs can resolve many of the money problems that rural families face, such as the payment of school fees, purchase of clothes or medicines or essential food items like oil or salt. The sale (or barter) of chickens can also enable farmers to acquire other domestic animals such as pigs, sheep, goats and cattle.

Economic studies have shown that although an increased supply of village chickens may slightly lower the price of those chickens, farmers will be able to sell more birds and their total income will be higher. Urban consumers in many regions have a preference for village chickens over intensively produced broilers and it is estimated that a very large increase in village chicken production would be needed before consumers in urban areas became oversupplied with chickens. Prices of village chickens (per bird and, even more markedly, per kg) are generally higher than intensively produced chickens and, if prices were to fall along with a more plentiful supply, it would be expected that urban consumers in most societies and cultures would eat more village chickens and fewer intensively produced broilers.

Questions concerning an increased off-take (in terms of sale and/or barter):

- Where can the eggs and birds be sold at a good price?
- When are the best times to sell chickens or eggs?
- Is it better to sell chickens or eggs?

Instead of selling chickens only when money is needed, birds or eggs should also be sold or consumed to maintain an optimal flock size throughout the year (see Section 6.2). Furthermore, farmers can plan ahead to produce and sell more birds before public holidays when people like to prepare feasts with meat.

If feed is scarce, it is best to sell eggs instead of taking the risk of raising chicks. On the other hand, chickens should be raised for sale when feed for scavenging is available in abundance, to make use of this cost-free resource.

Tips for extension staff to help with marketing surplus chickens and eggs:

- Inform chicken traders in central markets of areas where farmers are vaccinating against ND. Tell them that they will usually find chickens to buy if they make the effort to visit these areas. Newcastle disease also causes problems for chicken traders, because it can be difficult for them to buy birds at a reasonable price after an outbreak. Traders can also lose money if birds purchased from many different houses and areas become infected with ND and die before reaching the market.
- Encourage local communities to select their own chicken traders. Just as the community can choose community vaccinators, they can also choose people to take their surplus birds and eggs to central markets for sale. In this way, the farmers are more likely to get a fair price for their birds, and the profits involved in chicken trading will stay within the community. Training may be required to ensure that sales are fairly distributed and that trips to central markets are made when buyers are more likely to have money (e.g. the first week after government salaries are paid) and when major festivals are about to take place (e.g. religious or other holidays).
- Organise local market days, maybe monthly, and invite chicken traders, restaurant owners etc. to attend.

6.7.4 Food safety

Sick, dying or dead birds should NOT be consumed. They should be buried in a deep pit away from water sources and beyond the reach of predators. Consume only healthy birds from healthy flocks.

As apparently healthy birds might also be incubating a disease, and to improve food safety in general, the following precautions should also be taken.

Keep clean:

- wash your hands with soap before handling food and again (frequently) during food preparation
- wash your hands with soap thoroughly after handling poultry meat
- wash and sanitise all work surfaces and instruments used to prepare meat for cooking
- protect kitchen areas and food from insects, pests and other animals.

Separate raw and cooked food:

- separate raw meat, poultry and seafood from other foods
- use separate equipment and utensils, such as knives and cutting boards, for handling raw foods
- store food in containers to avoid contact between raw and prepared foods.

Cook food thoroughly:

- cook poultry meat, eggs and blood thoroughly
- foods such as soups and stews should reach boiling point. For meat and poultry, make sure that juices run clear, not pink.

Safe slaughtering practices

If an apparently healthy bird selected for slaughter is incubating a zoonotic disease such as HPAI, **the most dangerous period to the handler is during the slaughter and preparation of the bird**. In addition to the virus inside the bird, there will also be large numbers of virus particles on the feathers around the vent and on the head. Birds should be placed in scalding water (70 °C; this is approximately when steam comes off hot water but before it boils) for a minute before having their feathers plucked or their feathers burnt off in a fire. Scalding will also make it easier to remove (i.e. pluck) the feathers.

6.8 Egg production (sale and consumption)

Eggs can be used to produce more chicks, but once ND is under control and chick husbandry is improved, not all of the eggs are necessary to produce offspring. Many of the eggs laid can be collected and either sold or eaten by the farmer and their family. The eggs are therefore a useful source of extra income and a very good source of nutrition for all members of the family.

Families should generally be encouraged to eat more eggs when they own a productive chicken flock. In some regions, it is traditional to prohibit the consumption of eggs by women and children. Overcoming these traditions and gaining recognition for eggs as a valuable source of nutrients will help to improve nutrition in these regions. In areas where ND control and improved husbandry have been successfully introduced, consumption of eggs has increased. It is likely that most traditions prohibiting consumption of eggs developed because of the need to ensure that most eggs laid could hatch to produce replacement stock in the face of high mortality.

The development of an egg

All of the eggs that she will ever produce are already present in a young hen in the form of ova, which can be found in the **ovary** as tiny, whitish, bubble-like structures (Figure 19). When the hen is in lay, the ova grow one at a time to form yellowish egg yolks. Each ovum takes about 2–3 weeks to mature to a yolk. During the laying period, one egg yolk or **follicle** is released from the ovary every day and falls into the **infundibulum**, a funnel-like structure at the top of the oviduct. In the **oviduct**, albumen is deposited around the yolk and then, further along, in the **isthmus**, two shell membranes are formed to surround the albumen. After the egg is 'plumped' with water, the membranous egg moves into the **uterus** or 'shell gland' where the shell is deposited. The time taken from release of the follicle from the ovary until lay is usually a little over 24 hours.

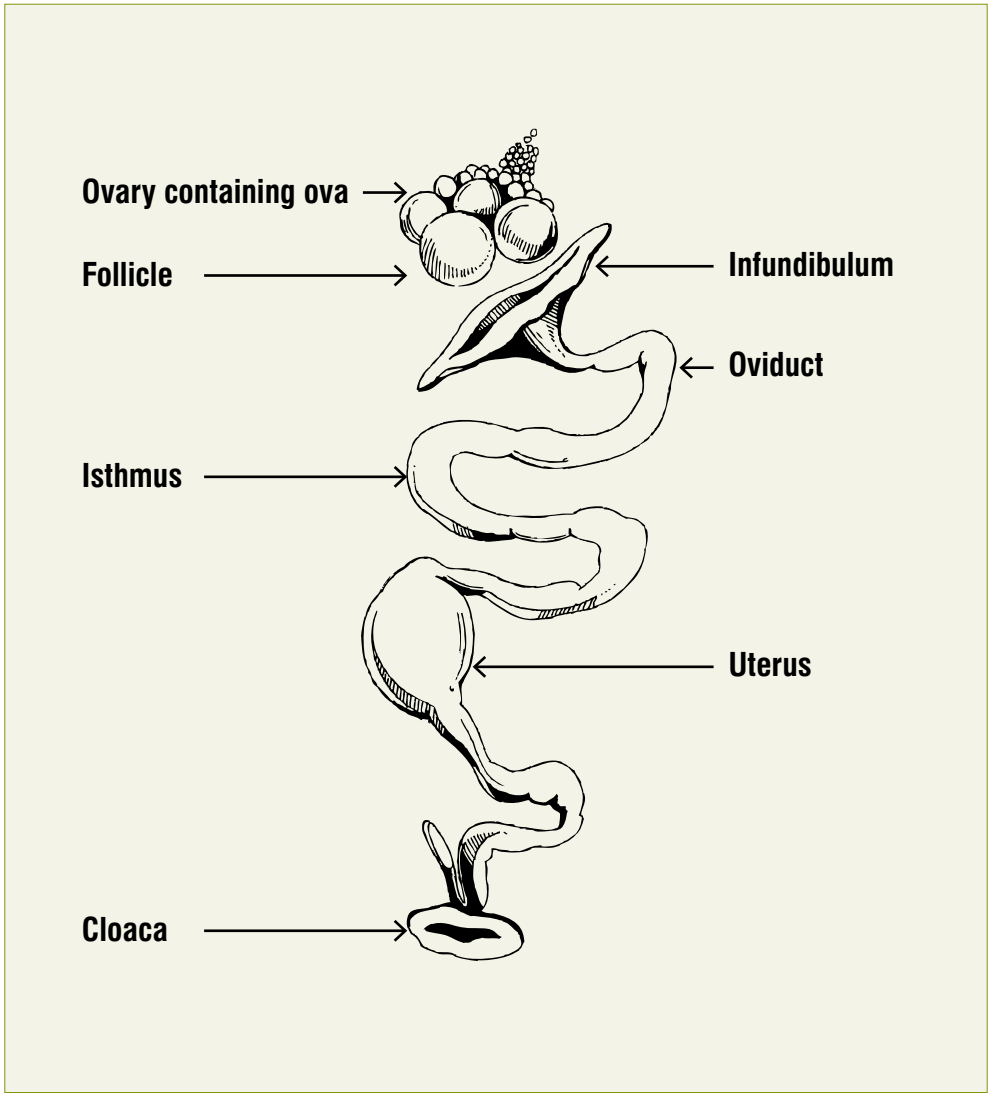

Figure 19. **Diagram of the female reproductive tract of a chicken**

6.8.1 Nutritional value of eggs

Eggs provide a range of essential nutrients and can make a substantial contribution to a healthy diet, especially for growing children, pregnant and nursing women, and HIV-positive individuals.

Each 100 g of eggs (a weight less than that of two eggs) contains about 13 g of proteins, 11 g of fats (in the egg yolk), 1 g of carbohydrates and 74 g of water (mainly in the albumen). The proteins contained in an egg are easily absorbed in the intestine and are therefore of high value for humans—even higher than the proteins contained in milk. In addition, a variety of minerals and vitamins (except vitamin C) are concentrated in eggs (Table 7). Research has also revealed that eggs contain several specific nutrients that have health-promoting properties, such as folic acid and iodine.

Table 7. Nutrient contents of 100 g of eggs

Main nutrients (g)		Vitamins (mg)		Minerals (mg)	
Proteins	13	E	2.02	Phosphorus	216
Fats	11	A	0.27	Potassium	147
Carbohydrates	1	K	0.05	Sodium	144
		B2	0.31	Calcium	56
Water	74	B1	0.10	Magnesium	12
		B6	0.08	Iron	2.1
		Folic acid	0.07	Fluorine	0.1
				Iodine	0.01

Extension workers should collaborate with colleagues working on human nutrition within the ministries of health and education to raise the awareness of families about good eating practices and the contribution that chickens and eggs can make to good health.

6.8.2 When to take eggs for sale or consumption

Eggs can be taken from every clutch before the hen has started to brood. Once the hen is brooding, the development of the embryo commences in fertile eggs (i.e. when a hen has mated with a rooster before starting to lay eggs; see Figure 13). It is recommended that these eggs be left with the hen. However, when a hen has not mated with a rooster before laying eggs, these eggs will be infertile and no chick will develop inside. Infertile eggs can be eaten even if the hen has sat on them for a few days. They can be identified by candling (see Section 6.4.3). These brooded eggs should be hard boiled (at least 10 minutes) or fried before consumption, to destroy any germs that might have penetrated through the eggshell.

It is advisable to consume or sell eggs instead of breeding chicks in times when the chance of survival for the chicks is low, such as when

- there is not enough feed for the chicks to survive (because of the season of the year or because too many animals are competing for the SFRB)
- the flock is already large and a further increase in stocking density is likely to cause problems
- chicks would be likely to suffer due to heavy rainfall or other seasonal and climatic influences.

6.8.3 Egg storage and conservation

How should eggs be stored?

With fertile eggs (when the hen has mated with a rooster) the embryo will start to grow even at ambient temperature (above 20 °C). Eggs should therefore be kept in a cool, shady place. A basket or box containing sawdust or bran placed in a hole in the floor in the coolest part of the dwelling makes a good store. For short-term storage, the way in which the egg is positioned is not important but, for long-term storage, there is some merit in storing the eggs with their pointed ends uppermost. Eggs for incubation should not be stored for longer than 2 weeks.

Do not store eggs kept for consumption beside items with a strong smell, as the eggs easily absorb the smell through the shell and the whole meal prepared with one of these eggs might be spoiled.

How long can eggs be stored before consumption?

If kept in a cool, shady place, a fertile egg will be suitable for home consumption for about 2 weeks, but it is desirable to use them before this if possible. In eggs that are not fertile, no embryo will start to develop but—as with fertile eggs—germs might enter through the shell and multiply inside the egg if it is stored for a long time at temperatures above 20 °C. Infertile eggs should therefore also be used within about 5–7 days if possible.

Eggs with a **broken shell** should be used immediately and consumed only after they have been cooked for some time (hard boiled, fried or well cooked with a meal).

How can fresh eggs be distinguished from old, bad eggs?

Place eggs in a container of water. Old eggs, which may be bad and which should not be eaten, will float in the water because a bubble-like chamber of air (the air cell) inside the egg gets bigger with the age of the egg (see Figure 20). This air chamber is smaller in fresh eggs, which will therefore stay at the bottom of the container filled with water.

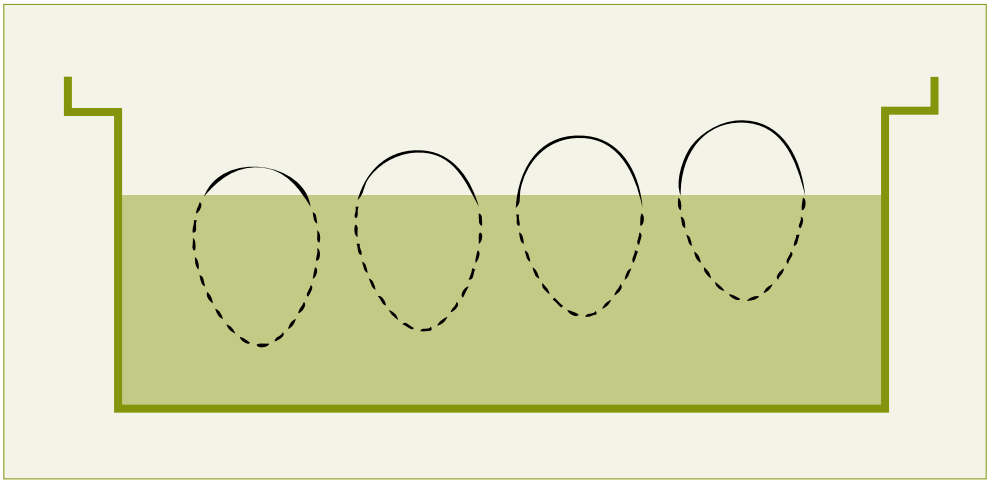

Figure 20. The freshness of whole eggs can be determined by floating them in water. Fresh eggs with a small air cell will sink lower (perhaps completely) in the water (eggs to the left) than will older eggs, in which the air cell has increased in size. The older egg is therefore lighter and so sits higher in the water (eggs to the right).

Fresh eggs can also be distinguished from old ones by the height of the albumen (the white or clear part of the egg) once an unboiled egg is opened and put on a dish (see Figure 21). The albumen of fresh eggs is quite high (maybe half as high as the egg yolk). In older eggs the albumen becomes watery and lies flat on the plate; the egg yolk is also flatter.

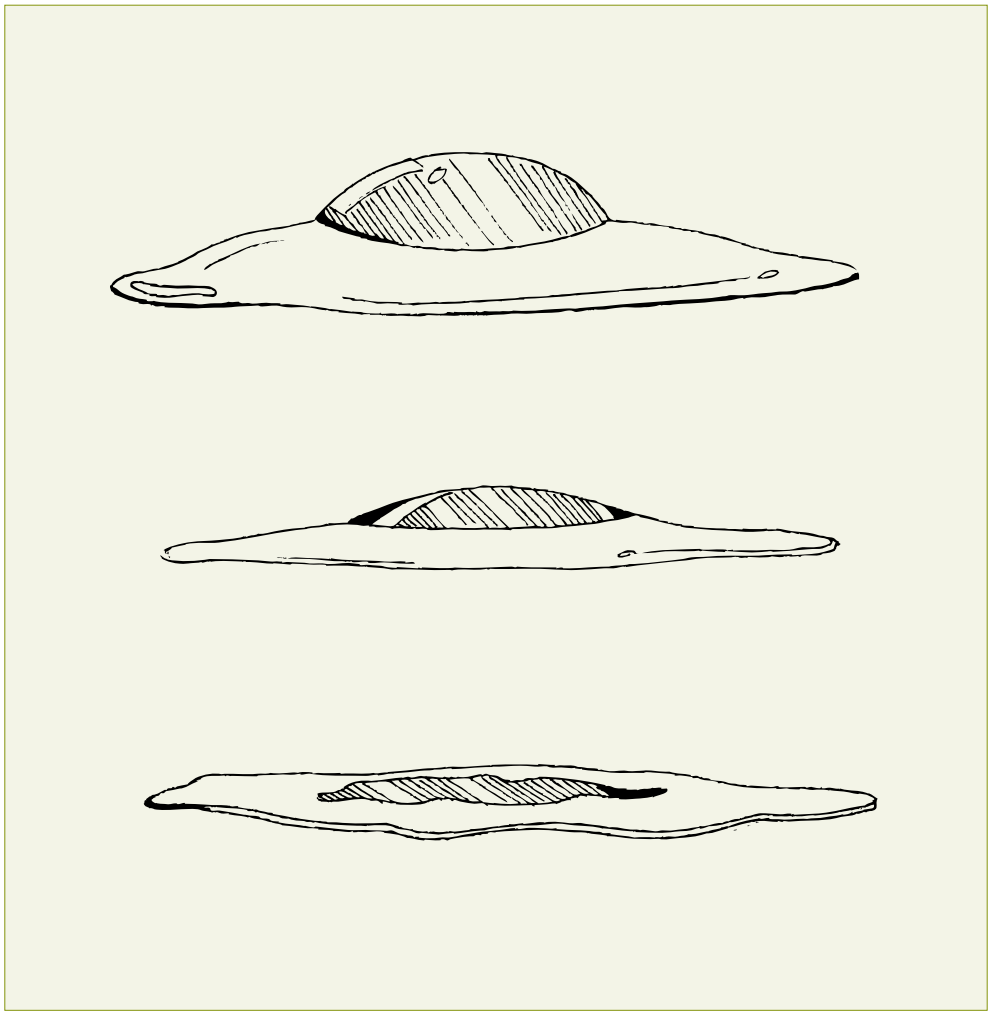

Figure 21. The freshness of an open egg can be estimated by breaking the egg onto a flat surface. The yolk will sit higher than the white in a fresh egg (top). As an egg ages, it will lose all structure, becoming completely flat (bottom).

How can eggs be preserved?

The quality of albumen declines very rapidly when eggs are stored at room temperature, especially in hot climates. Refrigeration is effective in maintaining quality for several months (Table 8). Oiling eggs on the day of lay will preserve their quality for several weeks. Wipe the egg with a little cooking oil after cleaning the shell. This will close the small pores in the eggshell and prevent moisture and carbon dioxide from escaping from the egg. The oil film also prevents germs from entering, provided the shell is clean.

Hard-boiled eggs can be stored for several weeks. These eggs might also be oiled to preserve their quality for even longer periods. Another possibility is to store raw eggs in water glass (sodium silicate) solution. Eggs will keep for several months in water glass if covered and stored in a cool place. The water glass solution is made by mixing one part of water glass (sodium silicate) to five parts of previously boiled but cooled water.

Table 8. Approximate safe storage times for eggs

Type of storage	Approximate length of storage
Eggs with a broken shell	Use immediately and do not store
Fresh eggs (fertile and infertile) stored in warm conditions (above 20 °C)	1–2 days. If unsure of the age of the eggs, test to see if they are spoilt, and hard boil or cook them well before consumption.
Fresh eggs (fertile and infertile) stored in a cool, shady place	5–7 days
Oiling egg on the day of lay and kept in cool, shady conditions (use cooking or vegetable oil)	2 weeks
Hard boiling eggs on the day of lay	3 weeks
Hard boiling and oiling fresh eggs	4–5 weeks
Stored in water glass (1 part sodium silicate to 5 parts of boiled and cooled water)	Several months
Refrigeration (where the temperature is constantly maintained around 4 °C)	4 weeks

6.8.4 Egg quality

The quality of an egg depends on:

- whether it is clean or dirty
- how long it has been stored
- the health status of the hen that laid it
- whether or not it is fertile.

Can dirty eggs be consumed?

Eggs should be cleaned before they are sold or consumed, as the dirt on the eggshell is likely to contain germs and may cause people to get sick. Wipe eggs with a dry cloth soon after collecting them. Do not wash eggs with water because that will destroy a very thin protective covering on the eggshell which protects the egg from germs.

Can eggs that have been taken from a brooding hen be consumed?

Once the hen is brooding, the development of the embryo will start in fertile eggs (if the hen mated with a rooster before starting to lay eggs). It is recommended that fertile eggs be left with the hen. Infertile eggs (which do not contain a developing embryo) might be taken from a brooding hen for consumption. The latter can be identified by candling the eggs at day 5–7 of brooding (see Section 6.4.3).

Can eggs cause disease in humans?

Some eggs might be contaminated with germs such as salmonella that can cause diarrhoea, especially in young children and sick and older people. Most of these germs are destroyed by heat, so, to avoid diarrhoea, eggs (at least

those of unknown origin) should be eaten only after being thoroughly cooked (e.g. hard boiled or well fried). It is always best to consume eggs that are as fresh as possible to avoid germs that may multiply inside the egg.

Does the colour of the egg yolk indicate its quality?

The colour of the egg yolk may vary from light yellow to orange, depending on the feed the chicken has eaten. The colour may reflect the vitamin content of eggs produced by scavenging or 'free-range' chickens that do not have access to commercial diets. Changes of the egg yolk to a greenish or brownish colour may be caused by drugs or toxins (Table 9).

Do stains or small spots in the albumen influence the egg quality?

Small stains or 'meat' spots in the eggwhite (albumen) are often caused by small amounts of coagulated blood that accompany the yolk at the time of its release from the ovary. They have no effect on the nutritive value or safety of eggs.

Why do some eggs smell like fish?

While eggs might smell like fish if the chicken's feed contained too much fish, some hens produce eggs smelling or even tasting like fish even if they are not fed fishy feed. The smell might then be caused by a substance called trimethylamine which can be produced after hens are fed rapeseed (also known as canola). The production of trimethylamine in a hen is an inherited characteristic and, if only certain hens are producing strongly smelling eggs, these birds should be slaughtered or, alternatively, not fed rapeseed. These hens can also be identified by opening their beaks and smelling their breath to see if it has the same strong smell.

Eggs may also have a fishy smell if the hen is suffering from salpingitis, an infection of the reproductive system.

6.8.5 Diseases and disorders affecting egg quality

Diseases in hens, as well as poor husbandry or nutrition, might affect egg production. A hen in bad condition will produce fewer or even no eggs. The quality of eggs may also be affected by several diseases and disorders. Table 9 summarises the types of changes in egg quality that can occur, and possible reasons for these changes.

Table 9. Reasons for reduced egg quality

Sign	Cause or contributing factor	
	Non-infectious	Infectious
Shape of the egg:		
Small size of eggs	Low body weight Imbalanced ration (lack of protein) Lack of water High ambient temperature Toxins	Infectious bronchitis Newcastle disease Diseases affecting the liver
Changes in the egg shape	Toxins	Infection with adenoviruses Infection with mycoplasmas Newcastle disease
Egg shell:		
Dirty shell	Diarrhoea in the hen Dirty nest	Spirochaete infection
Thin, perhaps cracked, shell	Lack of calcium, phosphorus and vitamin D3	Newcastle disease Infectious bronchitis Egg drop syndrome (EDS; adenovirus infection)
Lack of hard shell	–	EDS Avian influenza
Pale shell	–	Infection with pneumovirus Infectious bronchitis EDS
Rough shell	–	Infectious bronchitis
Albumen (eggwhite):		
Watery albumen	Old egg Toxins	Infectious bronchitis Diseases affecting the liver
Slightly pink albumen	Feeding cottonseed[a]	–
Egg yolk:		
Greenish colour	Feeding cottonseed[a]	–
Brownish colour	Using piperazine for deworming	–
Watery egg yolk	Old egg	Infectious bronchitis
Stained, spotted egg yolk	(Depending on the pigments contained in the ration)	Coccidiosis Worms

a Cotton plants contain gossypol, a natural toxin causing the change in colour.

6.9 Record keeping

A more active and interested farmer will spend some time each day observing their chickens.

The keeping of records is a very useful management tool. Where someone in a family can read and write, simple records will help the individual farmer as well as extension workers and other technical people to identify problems and optimise production.

Some of the production parameters that would be useful to record include (for each hen and her progeny):

- mortality (clinical signs and/or suggested cause)—flock statistics
- general laying ability (number of eggs per clutch)
- number of clutches per year
- number of chicks hatched
- number of chicks reared (to, say, 8 weeks of age)
- number of chickens and eggs sold
- number of chickens and eggs eaten
- vaccination and other treatments applied (when and with what).

7 Disorders related to poor husbandry or nutrition

Poor husbandry and nutrition will result in low productivity and may lead to disease or even death of the chickens. Disorders caused by poor husbandry or nutrition cannot spread from one bird to another (they are not infectious) but often the whole flock or age group is affected because all of the birds are living under similar conditions. Tables 10 and 11 give an overview of possible consequences of poor husbandry and nutrition.

Table 10. Chicken disorders caused by poor husbandry (other than nutrition)

Sign	Cause or contributing factor
Drop in productivity	High temperature, lack of water, overcrowding
Respiratory distress	High temperature, lack of water, overcrowding
Respiratory signs	Poor-quality air in the chicken house (due to high amount of wet faeces), overcrowding Chicken house does not protect the birds from rain or wind (leaking roof, wall with holes, poor location)
Diarrhoea	Moist chicken house, moist areas around the troughs leads to infectious diseases; dietary problem
Feather pecking Cannibalism	Crowded chicken house and other stresses
Lesions on the feet	Rough and/or dirty floor in the chicken house

Table 11. Chicken disorders caused by poor nutrition

Sign	Cause or contributing factor
Low productivity	Insufficient or poor-quality feed
Low hatching rate	Lack of vitamins
High chick mortality	Lack of vitamins or trace minerals, lack of feed or poor-quality feed
High susceptibility to any disease	Lack of vitamins, trace minerals or proteins
Retarded growth of body and feathers	Lack of vitamins or trace minerals
Soft legs that can bend in chicks	Lack of minerals (calcium, phosphorus) and vitamins (vitamin D)
Fractured legs and wings in laying hens	Lack of minerals (calcium, phosphorus) and vitamins (vitamin D)
Curled toes, deformed legs	Lack of vitamins (B vitamins)
Thin eggshells, eggs without shell	Lack of minerals (calcium, phosphorus) and vitamins (vitamin D)
Diarrhoea	Bad-quality feed (contaminated with infectious agents) Carbohydrate fractions in certain grains and grain legumes High salt levels
Blue comb	Lack of water
Central nervous signs	Lack of vitamins (B vitamins)
Sugar-like layer on inner organs (gout)	Lack of water, surplus of minerals, lack of vitamin A
Enlarged yellow liver	Lack of dietary proteins, surplus of carbohydrates or fats in the ration
Swollen kidneys	Lack of water, too much salt in diet

PART 3
Diseases and their control

This section provides a guide to diseases; their identification, prevention and control.

Reference is made to use of antibiotics and insecticides for the control of some diseases and infestations. In most cases, their use is of questionable value in village flocks. Unless general husbandry is improved, the single use of an antibiotic or insecticide is highly unlikely to significantly increase production in the medium to long term.

The misuse of antibiotics and insecticides can promote increased resistance to these products and reduce their efficacy in the long term. Therefore, if a decision is made to use them, care should be taken to ensure that:

1. the most appropriate medicinal substance or insecticide has been selected
2. its expiry date has not been passed
3. it has been properly stored
4. the instructions for its use are followed closely.

Remember that preventing a disease is better and generally cheaper than treating it. Preventing disease in village chickens by the strategic use of vaccination and improved husbandry is usually the most cost-effective approach.

8 Disease in village chickens

8.1 Introduction

Disease in village chickens can be defined as any change or impairment of normal body function that affects the birds' ability to survive, grow or reproduce. Societies have developed many theories about what causes disease in people and animals. Some theories suggest that disease is caused by evil spirits or by witchcraft. In parts of West Africa, for example, some people believe that their chickens die in large numbers just before Christmas because God needs them at this time. Advances in science and medicine have given us a much better understanding of the causes of diseases, which are discussed in Section 8.2.

> **Respect local ideas and beliefs that explain the occurrence of diseases** while also helping farmers to understand how a disease can affect chickens and, in the case of an infectious disease, how it is transmitted.

An understanding of the cause of a disease and its method of spread (transmission) will assist in controlling it. Knowledge of the clinical signs of a disease and the characteristics of lesions found post-mortem will assist in its diagnosis.

8.2 Causes of disease

Many diseases—called infectious diseases—are caused by organisms that can be transmitted from one bird to another. Some of these organisms are too small to be seen without the assistance of special equipment. Such organisms include viruses (ND virus, for example), bacteria (salmonella, for example), mycoplasmas, fungi and small parasites called protozoans (coccidia, for example). Other infectious organisms such as external (lice, fleas and ticks) or internal (roundworms, tapeworms, flukes) parasites are easier to see.

Other diseases can be caused by poor nutrition or husbandry (see Chapter 7), or are inherited. These diseases do not spread from one bird to another and affect only single birds or flocks.

In many cases, disease results from a combination of factors (Figure 22). Husbandry, nutrition, environmental factors and flock management all have a direct and important influence on the health and productivity of chickens. A well-nourished chicken kept under good husbandry conditions can fight diseases better and is less likely to suffer from many infectious diseases.

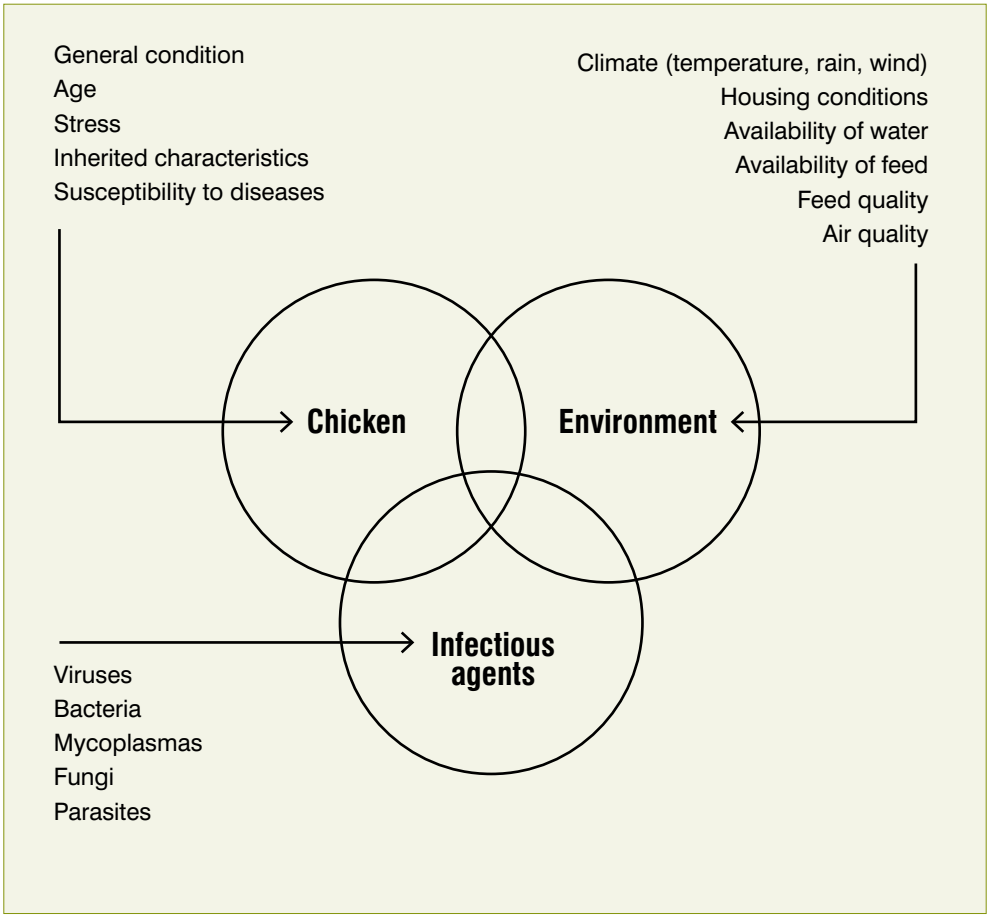

Figure 22. Factors influencing the health status of chickens (adapted from Woernle and Jodas 2001)

8.3 Transmission of infectious diseases

Diseases that are caused by viruses, bacteria, mycoplasmas, fungi or parasites (infectious diseases) can spread from one bird to another. The ways and mechanisms of this process, called 'transmission', must be understood if the correct measures are to be taken to prevent the spread of such diseases.

Most infectious agents enter via the beak while the chicken is eating, drinking or cleaning its feathers, or during breathing. Other infectious agents can infect a bird through a wound. The agent then multiplies within the chicken and may spread, causing damage (lesions) in certain organs and, consequently, clinical signs. After multiplication, some of the infectious agents leave the bird in its droppings, in discharges from lesions, in its breath, or even on dropped feathers. If other birds come in contact with these contaminated items, then they too may get sick.

Infectious agents can survive outside the bird for variable periods. Worm eggs and coccidia, for example, can survive for several months in the environment

while some other infectious agents are quickly destroyed by sunlight or heat. For spread of diseases caused by agents that are readily destroyed, direct contact between the birds is necessary. On the other hand, infectious agents that can survive for a certain time in the environment can also be spread via any person, animal or material that might carry the agent. The infectious agent might be carried with small traces of droppings on shoes, for example, or in the dust or small feathers attached to any rough surface, on the eggshell or with any part of a dead chicken.

When an infectious agent enters a bird, the bird does not get sick immediately. It usually takes some days for the bird to show signs of illness. This period is called the 'incubation period'. During the incubation period the bird does not look sick but the number of infectious organisms inside it increases rapidly and some organisms may leave the bird when it breathes or drinks or passes droppings (Figure 23). This means that **the agents causing an infectious disease can be spreading even before clinical signs of the disease can be seen.**

Some infectious diseases can also be spread vertically, i.e. from the hen to its offspring, by transmission through eggs. To date, vertically transmitted diseases appear to have been more of a problem in commercial poultry enterprises.

8.4 Notifiable diseases

Some infectious poultry diseases (particularly ND and HPAI) cannot be controlled by good husbandry and flock management alone. These diseases are caused by very strong and contagious viruses and can lead to very high losses in chickens or other poultry species. Because of the huge impact these diseases may have on poultry production and trade, they are notifiable all over the world, i.e. they are World Organisation for Animal Health (OIE) 'transboundary animal diseases'. Outbreaks must be reported to, and control measures coordinated by, the veterinary authorities.

8.5 Diagnosis of poultry disease

Since several factors may cause a disease or contribute to it, it is important to conduct a thorough investigation. This will assist you to make an accurate diagnosis, to understand why the birds got sick and to take appropriate control measures.

Examination of the sick chicken, the case history and an examination of the whole flock and its environment are important parts of the investigation. These provide the information needed to understand the course of any disease. Each of these is discussed in this chapter.

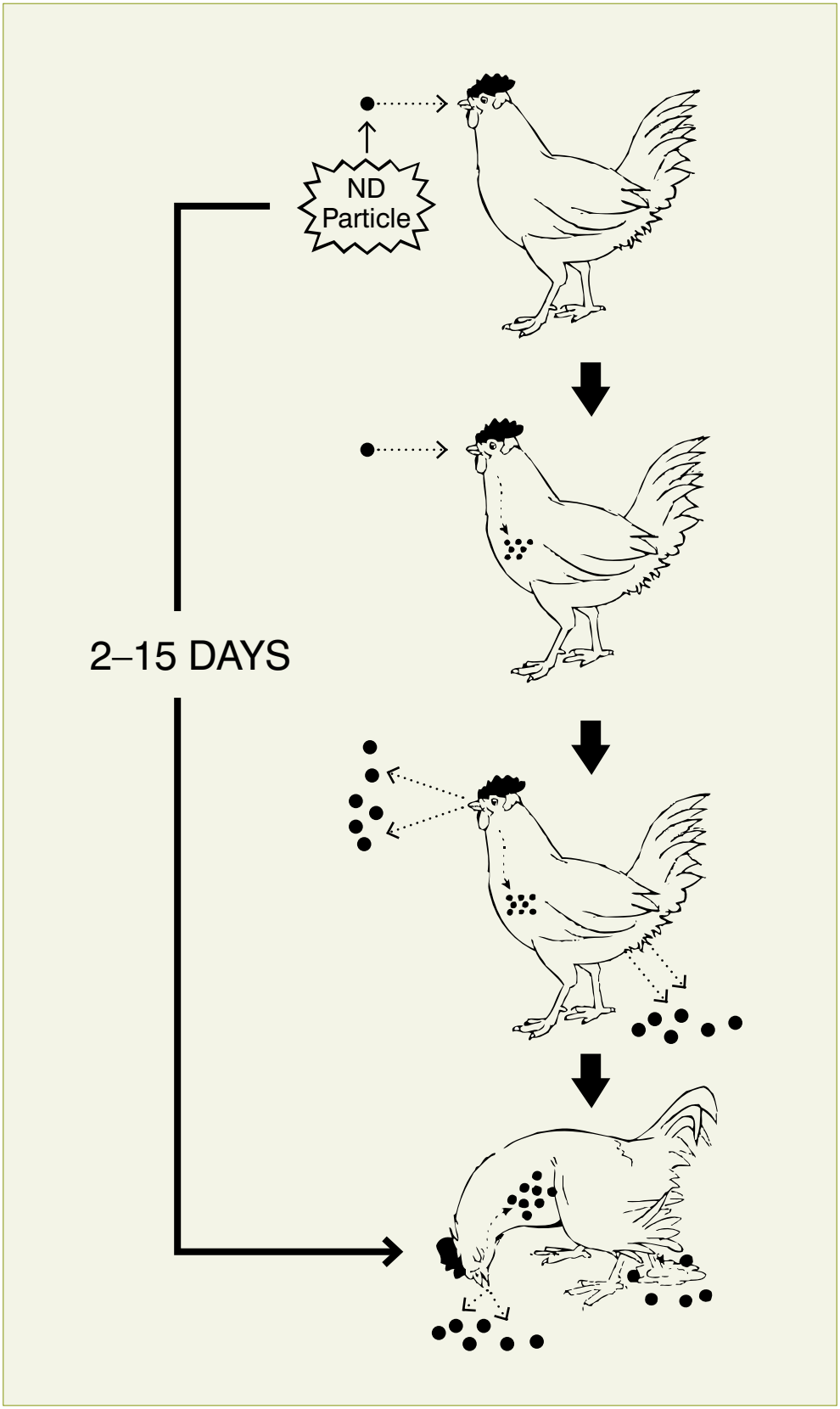

Figure 23. It takes 2–15 days from the time they come into contact with the Newcastle disease (ND) virus for birds to show signs of illness.

8.5.1 Case history

The case history will give information about the course of the disease (the number of birds affected, and the severity and duration of the disease), the means of introduction into the flock and whether or not the disease is infectious.

The person looking after the chickens should be asked the following questions since they generally have a better understanding of what is going on in the flock than the head of the household.

The farmer's observations of their chickens:

- Why do you think the chickens are sick? Describe the signs observed.
- What age groups are affected by the disease (chicks, growers, adults)?
- When did your chickens become sick?

The severity and nature of the disease:

- How many chickens do you have? How many of them are sick?
- Did any of your chickens die? OR Have any chickens been slaughtered recently because they were sick? If yes: how many?
- Do you have other birds besides chickens? Are they sick too?

Husbandry factors:

- Do you provide feed and water for your chickens?
- If yes: how often do you provide them with fresh feed and water? What do you feed your chickens with and how much do you give them?
- Where do you keep the chickens at night?
- If you provide housing for your chickens, how often do you clean the shelter?
- Did you use any traditional remedies or drugs in your chickens?
- Have the birds been vaccinated? When? What vaccine was used?

How the disease might have entered the flock:

- Do birds in neighbouring flocks show the same signs? If yes, how many flocks are affected?
- Did you bring new birds to your household recently?
- Did you recently visit someone whose chickens were sick? OR Has someone whose chickens are sick recently visited your homestead?

8.5.2 Clinical examination of the whole flock and its environment

This examination will provide information on the health status of the flock and confirm the information provided by the person looking after the chickens. Since chickens in poor condition are more likely to get sick from any infectious agent, an assessment of housing and nutrition is also important.

Examination of the whole flock:

- Are the chickens active?
- Do they scavenge for their feed?
- Is feed and water provided? If so, is the feed fresh or old and/or mouldy?
- How many of the chickens are sick?
- Which age groups are affected by the disease?
- What does the plumage (feathers) look like?
- What do the droppings look like?
- Are the hens laying eggs as normal?
- What do the eggs look like?

Examination of the environment:

- If the farmer provides housing:
  - Where and how are the chickens kept at night?
  - Is the shelter clean?
  - Is the shelter crowded at night?
- If the farmer provides feed/water:
  - What is the quality of the feed or water provided?
  - Is the drinker or feed trough clean?
- Do the chickens find feed and water in the surroundings of the homestead?
- Are there many droppings close to the chicken house, waterer or feed trough?

8.5.3 Clinical examination of sick birds

To examine a sick chicken you will have to catch and hold it in your hands (Figure 24). If there is a possibility that the chicken is infected with HPAI or any other disease that can also infect humans, then appropriate safety measures should be used (see Section 11.2). A hook made of wire might help you to catch chickens (Figure 25). The design of the hook is important and will depend on the age and size of the birds. It is important that the hook is used in a way that does not injure the bird (Figure 26).

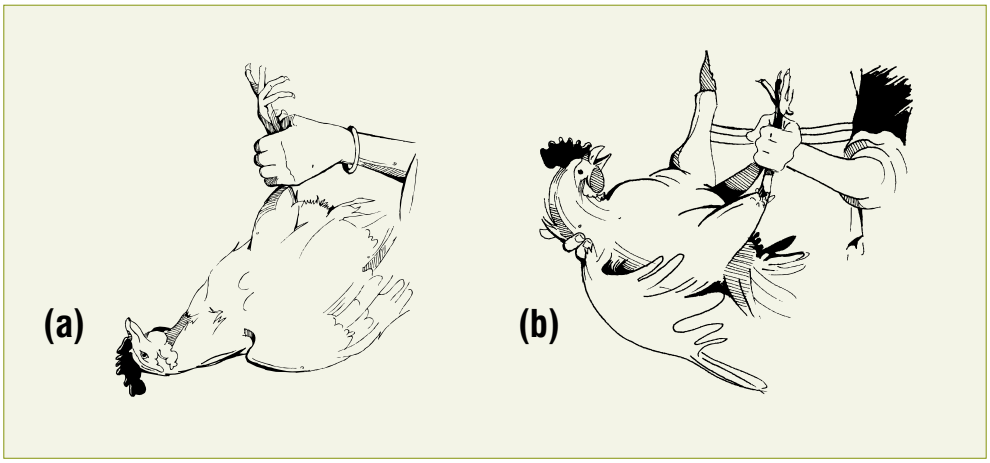

Figure 24. Birds should be handled correctly to minimise stress. Do not hold birds by their legs only (a). Rather, use two hands to hold both the legs and support the bird's neck (b).

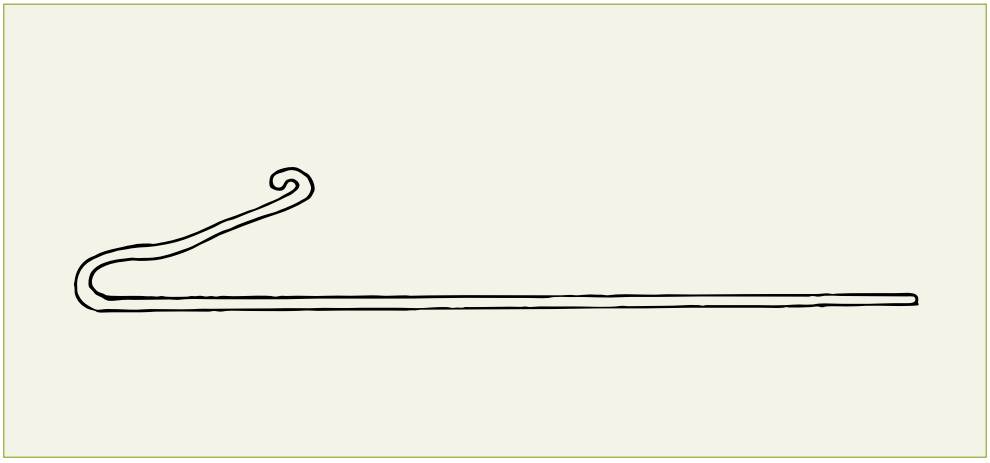

Figure 25. Design of a wire hook for catching chickens

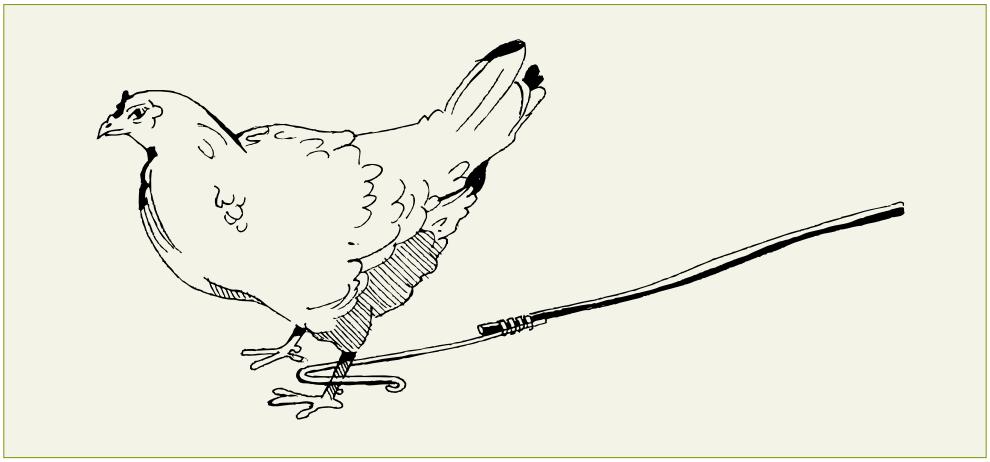

Figure 26. Correct use of a wire hook to catch a chicken

Examine the bird thoroughly for the following signs:

General signs

- Is the bird active or sleepy?
- Are the feathers smooth, clean and free of external parasites?
- Is the bird well nourished? (Feel the breast muscle of the bird: birds that have been sick for a long time lose body weight and have a thin breast muscle. Feel the muscle of other birds for comparison.)
- Has the bird eaten within the last few hours? Feel the crop to confirm.

Respiratory signs

- Is the bird breathing through an open beak?
- Is the breathing noisy?
- Is the bird coughing or sneezing?
- Are there swellings around the eyes and discharge from the eyes, nose or beak? If present, nasal discharge can be squeezed out by pressing gently above the nostrils.

Diarrhoea

- Are the feathers around the vent dirty? The feathers will be dirty when the bird has diarrhoea.

Nervous signs

- Does the bird show any nervous signs (e.g. twisted neck, trembling)?

Movement

- Is the bird lame?
- Are the joints swollen?
- Are the legs and wings in a normal position?

Skin and feathers

- Are there external parasites on the feathers and on body regions with few feathers (head, under the wings, above the vent)?
- Are there injuries or lesions on the bird's skin, especially on the head, comb and wattles?
- Are the feathers damaged?
- Are there changes in colour (pale, dark, bluish) or size of the comb or wattles?

Table 12 (see also Table 15 in Chapter 10) indicates that several diseases of village chickens may cause similar clinical signs. In most cases, clinical examination and the case history provide information that allows a clinical diagnosis to be made, but do not reveal the definitive cause of the disease. A particular cause (e.g. coccidiosis if bloody diarrhoea in younger chicks has been observed) may be suspected but a proper clinical diagnosis has to concentrate on actual facts (e.g. 'bloody diarrhoea, suspected coccidiosis').

This manual therefore concentrates on the identification of clinical signs and describes how a clinical diagnosis may be reached. Chapter 9 provides general information on prevention and control of infectious diseases. A detailed description of individual diseases is then given in Chapters 10 and 11. The diseases in Chapter 11 are listed in alphabetical order to make it easier to locate them.

Appendixes 3–5 provide information on post-mortems, sample collection and serology for those who have the equipment to perform these procedures.

Table 12. Clinical signs that may be present in sick chickens and possible reasons for their occurrence

	Clinical signs	Possible reasons
General	Depression, listlessness, inappetence, drooping wings, low productivity	Wide range of causes
	Emaciation	Chronic, long-lasting disease
Respiratory system—breathing	With open beak	Newcastle disease (ND), infectious laryngotracheitis Other severe respiratory disease Very hot weather
	Distressed, noisy, rattling	ND, highly pathogenic avian influenza (HPAI), severe respiratory disease
	Coughing, sneezing, wheezing, gurgling	Infectious coryza, infectious bronchitis (IB), chronic respiratory disease (CRD), other respiratory disease Fowl cholera
Respiratory system—nostrils	Wet or crusted because of nasal discharge	Infectious coryza, CRD, other respiratory disease
Eyes	Swelling around the eyes	Infectious coryza, CRD, other respiratory disease ND, fowl cholera
	Discharge	Infectious coryza, CRD, other respiratory disease Fowl cholera
	Cloudy pupils	Various reasons
Alimentary system	Dirty vent	Coccidia, worms, spirochaete infection ND, infectious bursal disease IBD/Gumboro disease Fowl typhoid, pullorum disease, fowl cholera, colisepticaemia or other infectious disease

Table 12. (continued)

	Clinical signs	Possible reasons
Nervous system	Twisted neck (torticollis)	ND, HPAI or any other disease affecting the nervous system
	Lameness (paralysis)	ND or any other disease affecting the nervous system
	Trembling, shaking	ND or any other disease affecting the nervous system
Musculoskeletal system	Lameness	Crusted legs due to scaly leg mites Marek's disease Other reasons
	Swollen joints	Fowl cholera Various other reasons
	Abnormal position of legs	Marek's disease Nutritional deficiencies Any accident Various other diseases
	Swellings under the feet	Infected injuries
Feathers	Small spots, maybe moving	External parasites—lice or mites
	Moulting	Usual moulting process (once a year) Under stress
	Ruffled	General sign indicating that a chicken is sick
	Lesions, damage	Lice Feather pecking or cannibalism
Skin	Pale skin	IBD/Gumboro Severe infestation with external parasites, especially the red fowl mite
	Dark, bluish (bruising)	HPAI, ND, aspergillosis, IBD/ Gumboro
Skin—comb	Yellowish to dark-brown crusty spots	Fowl pox
	Pale	Chronic diseases Severe infestation with parasites
	Dark, bluish	Acute feverish diseases affecting the circulatory system (e.g. fowl cholera, HPAI, ND)
Skin—wattle	Yellowish to dark-brown lesions	Fowl pox
	Dark, bluish	Acute febrile diseases affecting the circulatory system (e.g. fowl cholera, HPAI)
	Swollen	Fowl cholera, HPAI, ND
Inside the beak	Yellow–white cheesy-looking lesions	Fowl pox

9 Disease control

9.1 Introduction

To keep chickens in good health and support high productivity it is necessary to control the diseases affecting the birds. Effective disease control includes measures taken to cure or eradicate a disease as well as measures designed to prevent it.

What should be the aim: eradication or control?

It is not always possible to eradicate the cause of an infectious disease, especially if wild birds also carry the infectious agent or if the infectious agent is very widespread (endemic). However, it is possible and desirable to control the clinical diseases caused by many infectious agents. For example, ND virus is endemic in many regions and is therefore almost impossible to eradicate. Nevertheless, the clinical signs of ND can be avoided by regular vaccination and good biosecurity.

9.2 Tools used to control diseases in village chickens

The following are among the measures required to ensure comprehensive disease control.

9.2.1 General measures

Husbandry, nutrition, flock management and environmental factors have a direct and important influence on flock health (discussed in Chapter 8). Improvements in these areas should generally be part of the control of any disease (see Part 2—Housing, nutrition and management).

9.2.2 Hygiene (biosecurity)

Procedures described in the **sanitary rules** (see Section 9.3) will help to prevent the entry and spread of infectious diseases and contribute to improved flock productivity and production of better-quality eggs and meat.

9.2.3 Traditional remedies

In many countries, farmers use traditional remedies to treat diseases of village chickens. Some of the remedies may be effective, and others less effective or even harmful. This manual does not deal with the large range of traditional remedies that are used. However, local extension officers should identify and test remedies used in the areas where they work.

No known cure for ND or HPAI

There is no known cure (traditional or otherwise) for diseases such as ND and HPAI. The best way to control ND is through prevention, the most important aspect of which is vaccination.

9.2.4 Vaccination

Vaccines can protect animals from infectious diseases but **they cannot treat a disease**. Moreover, vaccines are disease-specific and protect animals against only a specific disease rather than all diseases. Vaccines work best on healthy, well-fed animals that are not suffering from parasites or other diseases. **Do not vaccinate weak or sick birds. If a bird is already incubating ND or another killer disease, the chicken will die and farmers may be angry or discouraged, and lose confidence in the vaccine.**

Commercial vaccines (produced by large pharmaceutical companies) can prevent many diseases in poultry. Nevertheless, their use is often not practical under village conditions because many require continuous refrigeration (referred to as 'a constant cool chain') and are delivered in packages containing a large number of doses beyond the needs for small, village flocks. In addition, some diseases, such as infectious bursal disease (IBD; also known as Gumboro disease), that are of concern for commercial poultry units are of little or no economic importance under free-range conditions.

Vaccine specificity

Farmers must understand that vaccination with a particular vaccine protects their chickens against only a specific disease and that their chickens might suffer from other diseases despite successful vaccination. An example can be used to explain this: children vaccinated against polio or measles might still get malaria.

9.2.5 Commercial medicines and insecticides

A variety of products (e.g. antibiotics, insecticides and anthelmintics) might be available in local supply shops for treatment of poultry diseases. If you intend to use them, ensure that the labels on the materials available indicate that they are formulated for the treatment of the particular diseases. Always follow the instructions on dosage and method of application given on the label or information leaflet.

- To calculate the correct dose, be aware that sick chickens might feed and drink less than normal. Four to five healthy chickens drink 1 litre of water per day.

- Drugs that have to be administered via the drinking water might lose their potency if added to dirty water. Clean the trough thoroughly and use fresh, non-chlorinated water to administer drugs.
- The use of most insecticides requires special safety precautions, which are given on the instruction leaflet.

REMEMBER: Medicines alone will not eradicate a disease. Clean the chicken house and remove infectious material as described in this manual. Always make sure that enough fresh water, feed and proper housing are available for sick birds to help them recover from a disease.

9.3 How to prevent a disease entering a village chicken flock

Farmers should obey the following sanitary (biosecurity) rules, which together are a cheap and a very effective way to prevent infectious diseases.

- Clean the chicken house, troughs and nests regularly.
- Provide separate night housing for the different poultry species.
- Encourage separation between animal species and between animals and humans; waterfowl should be separated from chickens and turkeys.
- Regularly clean out and dispose of manure, and preferably compost it for at least 3 weeks.
- Dispose of sick and dead animals and infected materials correctly, and clean and disinfect/decontaminate thoroughly (see below).
- Avoid introducing new birds of unknown origin or from a sick flock into the 'home' flock.
- Always scrub cages, egg trays etc. with disinfectant or detergent and allow to dry before bringing them onto the farm. Farmers should be reminded that manure, dirt, feathers etc. will stop the disinfectant working properly. If they do not have any disinfectant, they should put the items in a sealed, black plastic bag in direct sunlight for 1 day so that the high temperature inside can inactivate disease agents.
- Keep new birds separate from the flock for 2 weeks to see if they become sick.
- Avoid contact of the 'home' flock with visitors, cages or animals from an area where there is a disease outbreak in poultry.
- Wash hands with soap after handling birds from other flocks.
- Vaccinate against specific diseases, which is possible but not always practical under village conditions (see previous section). Regular vaccination against ND is the only effective way to control this disease.

- Well-nourished birds can better fight disease. If possible and where necessary, farmers should provide their chickens with supplementary feed (Section 5.6) to prevent diseases caused by nutritional deficiencies and to promote good health.
- Chickens should not be bought from the markets or neighbouring villages at times of the year when outbreaks of disease such as ND are more common (Figure 27).
- Slaughter only healthy birds from healthy flocks for consumption. Immerse the bird in boiling water for a minute before plucking the feathers. This will make the feathers easier to remove and inactivate any infectious agents on the outside of the bird.
- In villages where birds are dying of disease, no birds should be slaughtered for consumption.

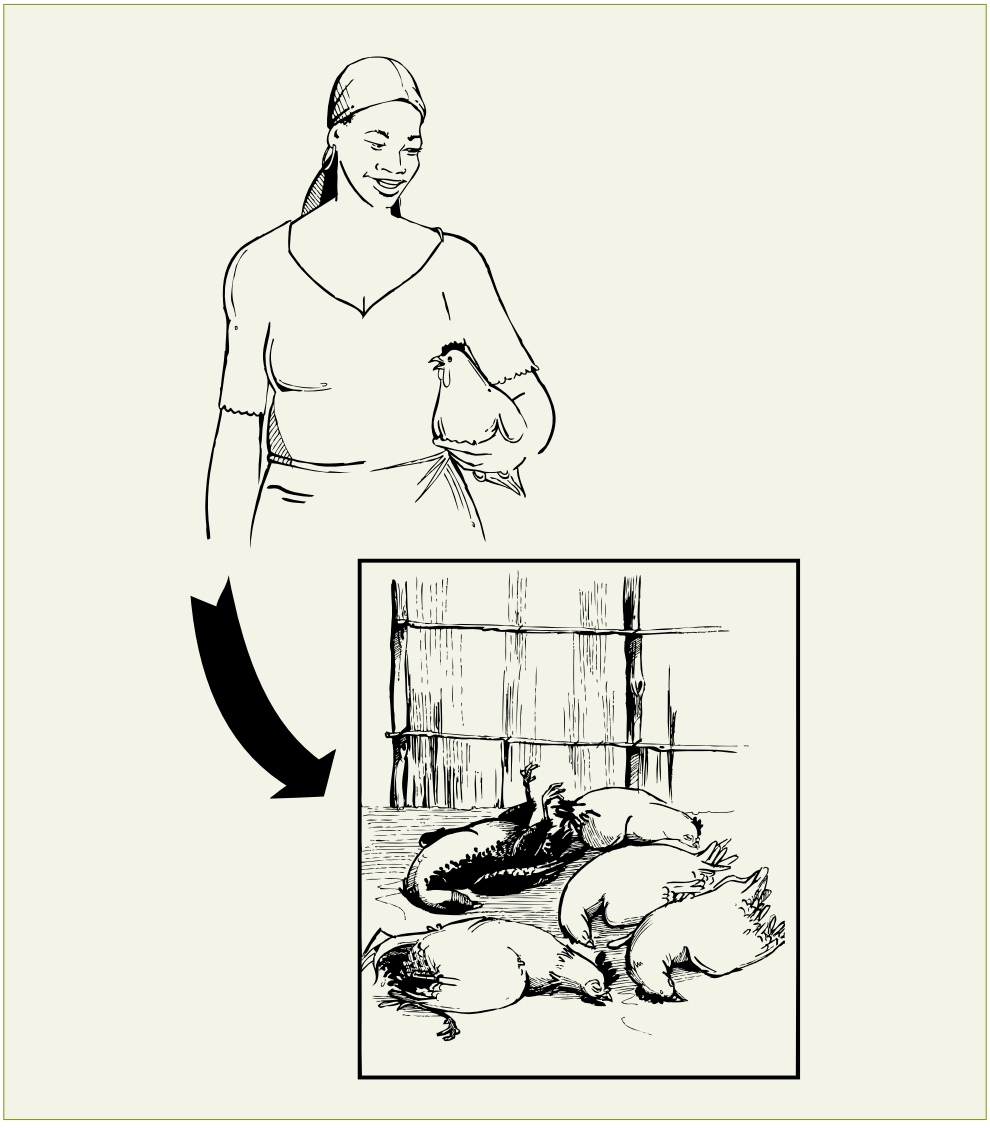

Figure 27. Do not introduce new birds to flocks during outbreaks of disease.

9.4 How to control a disease outbreak in a village chicken flock

If they detect illness in one or more of their flock, farmers should take the following steps to control the spread of the disease.

- They should separate chickens showing signs of illness from healthy birds (Figure 28). Sick chickens could be placed in a separate chicken house or cage. Always ensure that water and feed are available nearby should they wish to drink or eat. Similarly, place new stock into a cage or pen that isolates them from the main flock for at least 2 weeks, to ensure that they are not carrying any diseases that could be transmitted to the flock.
- They should not take sick chickens to another area that is free of the disease.
- They should slaughter very sick chickens. This is the best approach to take under such circumstances.
- They should burn or bury dead chickens or the remains of a slaughtered sick bird immediately. If, for any reason, the whole bird cannot be burnt or buried, then all parts of the bird (e.g. bones, feathers etc.) that remain should be burnt or buried (Figure 29).
- If high losses occur in their flock, they should inform their local livestock services.
- They should clean their chicken house frequently and thoroughly. Droppings should be removed as often as possible to avoid further spread of the disease. Wood ash or lime should be places on the floor and walls.
- They should not introduce new birds into the 'home' flock if they suspect that the chickens in the 'home' flock are suffering from an infectious disease. Newly introduced birds may also become infected with the disease.
- If high losses occur in a chicken flock, the farmer's best approach is to slaughter all birds and wait for some time before restocking. For example, if birds have died from ND, farmers should wait 30 days after the last bird died before introducing new birds. ND virus should be inactivated after 30 days in most tropical conditions but it can survive for up to 6 months in cool, damp locations. The minimum interval before restocking after an outbreak of HPAI is 21 days, provided that the poultry premises have been thoroughly cleaned and disinfected at least twice during this period. Under most village conditions, however, it is advisable to wait 45–60 days.
- If high losses occur in the flock it is best to burn the chicken house and build a new one in a different location. Manure from the sick flock should also be buried in order to avoid further spread of disease.

Figure 28. Sick chickens should be separated from healthy chickens.

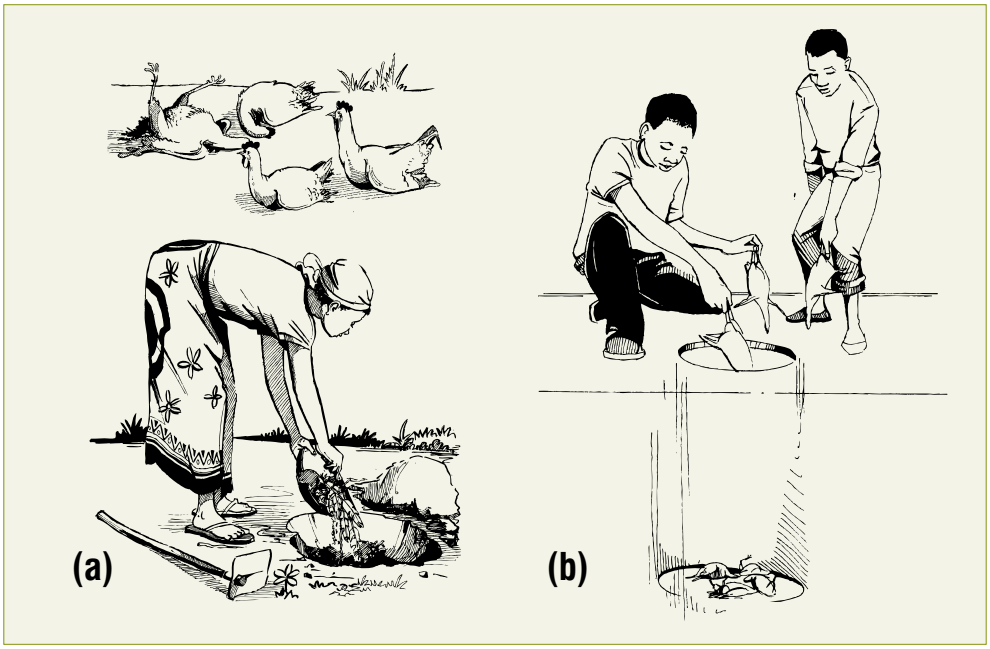

Figure 29. Birds killed by disease, or their remains, should be buried (or burned) to stop the disease spreading to new areas (a). Burial pits should be at least 1 m deep (b) if possible and well away from water sources such as wells and rivers. Hands should be washed and clothes washed or boiled after dead birds are handled.

10 Newcastle disease

10.1 Cause and impact

One of the major constraints to village chicken production is ND. In many countries, outbreaks of this disease regularly kill 50–100% of susceptible chickens. In countries where ND is common, outbreaks can occur once or twice a year. The fact that ND has a local name in many countries indicates the importance of this disease.

Newcastle disease is caused by a paramyxovirus that occurs in a range of types (or strains) of widely variable strength (virulence). Sometimes, the strain of virus present will cause very few deaths in chickens; at other times, the virus strain involved may cause many deaths. For example, if a farmer has 10 chickens, then infection with a:

weak ND virus may cause (i.e. lentogenic ND virus)	death of 1 of the 10 chickens
moderately strong ND virus may cause (i.e. mesogenic ND virus)	death of 5 of the 10 chickens
very strong ND virus may cause (i.e. velogenic ND virus)	death of all 10 chickens

10.2 Transmission

Newcastle disease is very contagious. This means that the disease can spread from one chicken to another very easily. The ND virus is passed in the bird's droppings, breath and any discharge from its eyes or nose.

Although the ND virus can be destroyed (inactivated) quickly at temperatures above 8 ºC (i.e. the virus is 'thermolabile'), it might survive for several months inside clumps of bird droppings.

Figure 30 illustrates some ways that ND virus can be spread (transmitted) from bird to bird:

- The droppings of a bird with ND can spread the virus.
- Dogs or predators can spread the virus by carrying a chicken carcass infected with ND to a different location and by distributing the uneaten parts (e.g. feathers and bones).
- If eggs come from or have contact with a chicken sick with ND, then the ND virus can contaminate the shell and be carried on the outside of the egg. Vertical transmission (spread from the mother hen to her chicks through the embryo) of ND virus has not been proven.
- Cars or other vehicles passing through an area where an ND outbreak is occurring could carry the ND virus to other areas on their tyres.
- Chicken organs, bones, intestines, feathers, feet or other parts or products from a sick chicken that have not been cooked can all carry the ND virus.
- People can carry the virus from one flock to another on their shoes or clothes.

Furthermore, the ND virus can be transmitted by:

- direct contact between infected birds
- inhalation of contaminated air by uninfected chickens
- intake of contaminated feed or water
- contact with infected wild birds
- contaminated chicken houses
- contaminated baskets, cages, hoes or other equipment.

The role of humans in the spread of Newcastle disease (ND)

In areas where the movement of birds is not controlled, farmers often sell some of their birds before and/or during ND outbreaks. Birds that have come into contact with the ND virus can spread it to other birds in the market. So it is possible that healthy-looking birds purchased at the market could develop ND when taken home. People working in villages (e.g. farmers, vaccinators, traders, extension workers etc.) may also spread the disease by carrying ND virus on their shoes and equipment from households with sick birds to other households.

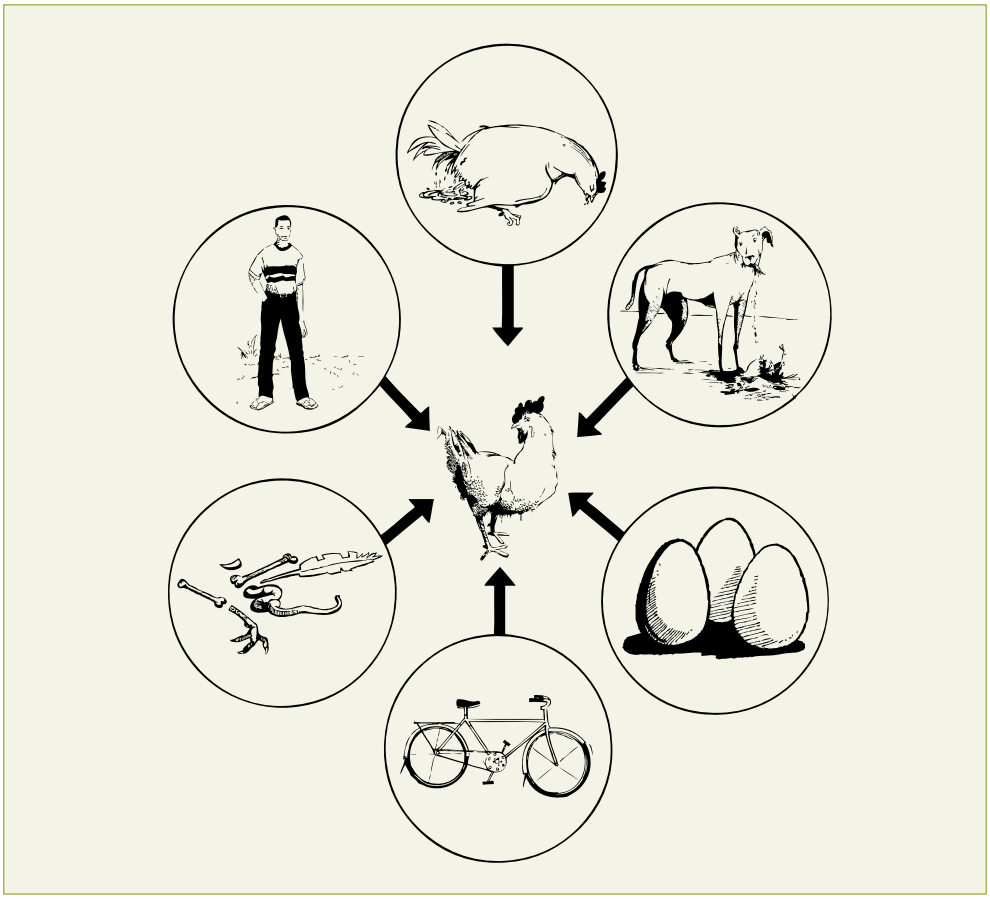

Figure 30. The Newcastle disease virus can be spread in many different ways through contact with infected animals and animal parts, and mechanical transmission of the virus via people and vehicles.

10.3 Species affected

As well as chickens, domestic poultry such as turkeys, guineafowl and pigeons may be affected by ND. Ducks are usually resistant to the disease but, on occasions, ducklings may be affected. Wild birds can also carry the ND virus.

10.4 Clinical signs

After contact with the ND virus, it usually takes 3–5 days for unprotected birds to show signs of illness. Sometimes, however, illness may occur within 2 days, and at other times it may take up to 15 days for clinical signs to appear.

The clinical signs of ND vary considerably according to the type (virulence and tropism) of the ND virus involved, the species, age and immune status of the bird, and environmental conditions. As a result, there are no clinical signs that are unique to ND (i.e. there are no pathognomonic signs). Indeed, chickens infected with virulent (strong) ND virus strains may die before any signs of illness are seen.

Signs of illness may include one or more of the following:

- The chicken fluffs its feathers and appears to 'have its coat dragging on the ground' (Figure 31).

Figure 31. Farmers in many parts of the world have observed that a chicken with Newcastle disease 'has its coat dragging on the ground'.

- The chicken looks sleepy (lethargy) and does not eat (inappetence).
- The chicken has slight difficulty breathing (respiratory signs such as mild rales and snick can be detected by careful observation).
- There is severe respiratory distress and gasping.
- The head and neck are swollen.
- There is greenish diarrhoea.

- Egg production decreases markedly. Sometimes deformed eggs are produced.
- When the disease is advanced, nervous signs such as shaking (tremor), torticollis (twisted neck), convulsions and paralysis of the wings and legs may be seen (Figure 32).

Figure 32. Torticollis is generally seen in chickens only when Newcastle disease is at an advanced stage.

- Mortality may be very high, often reaching 50–100% (Figure 33).

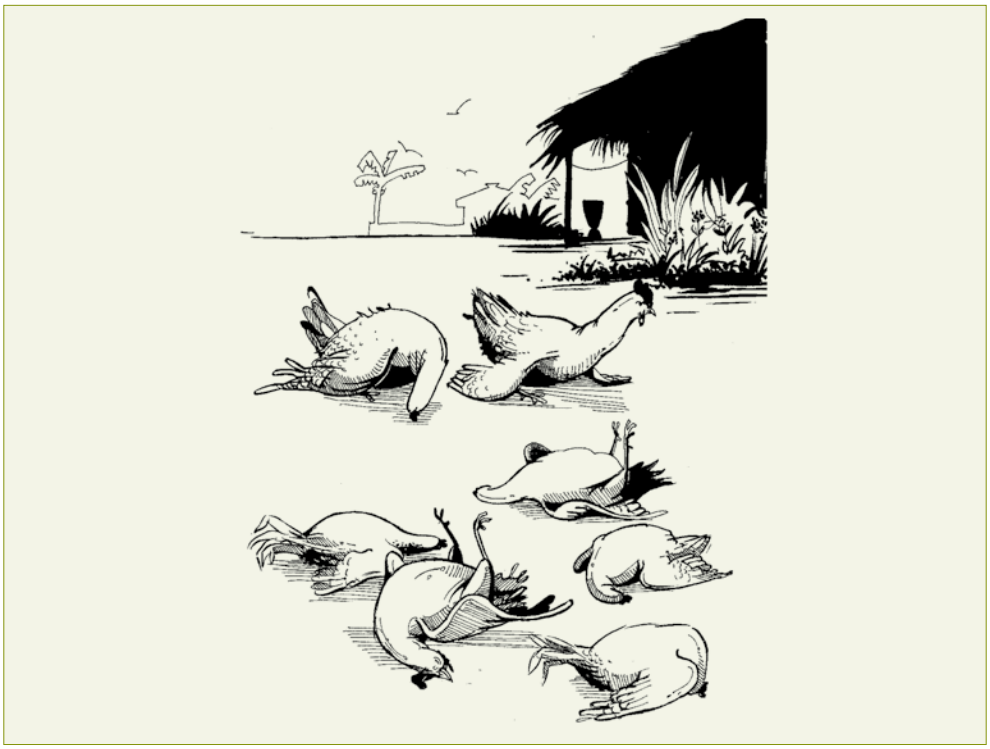

Figure 33. Newcastle disease or highly pathogenic avian influenza virus should be suspected when mortality of 50–100% is observed in a flock of chickens.

10.5 Post-mortem findings

Post-mortem findings are characteristic but not definitive (i.e. not pathognomonic). Newcastle disease should be suspected if the following lesions are encountered, particularly if they occur in combination (and when the flock history is also consistent with ND):

- reddening (congestion) and clear watery fluid (mucous exudates) in the trachea
- congestion of the lungs (lungs are heavier than normal and sink in water/formalin)
- haemorrhages of the mucosa of the proventriculus
- haemorrhagic and necrotic ulceration of lymphoid patches of the intestine, caecal tonsils and bursa of Fabricius
- congested ovarian follicles in hens in lay.

10.6 Field diagnosis of Newcastle disease

Accurate field diagnosis of ND in village chickens is often difficult, but when it is achieved it will assist in determining the prevalence of ND in the area concerned.

Case definition

In regions where the disease is endemic (and highly pathogenic avian influenza is not present) and where a laboratory confirmation of Newcastle disease (ND) is not possible, **an outbreak of ND should be suspected when there is high mortality in three or more neighbouring chicken flocks.**

To assist with diagnosis, it is best to separate cases according to the level of mortality observed:

- **High mortality in flocks not vaccinated against ND**. When 50–100% of birds in a flock die with the clinical signs listed above, it is likely that the deaths were caused by virulent ND. Highly pathogenic avian influenza can also cause high mortality but HPAI is currently endemic in a few limited areas whereas ND is endemic in many countries worldwide.
- **High mortality in birds vaccinated against ND**. This circumstance requires detailed and rapid investigation. It must be determined if:
  1) vaccination against ND was unsuccessful and, if so, why

     OR

  2) the birds have been infected with HPAI.
- **Low mortality.** In circumstances of low mortality it is more difficult to diagnose the disease involved. In areas where the majority of chickens are vaccinated against ND or have survived a natural outbreak of the disease,

infection with virulent ND virus will provoke mortality only in those chickens that are not immune. In this case, it is necessary to distinguish ND from other diseases that cause mortalities (such as IBD/Gumboro, fowl cholera and fowl pox). Unfortunately, there are no pathognomonic clinical signs or post-mortem lesions. When field diagnosis is not easy, it is always best to confirm the diagnosis by submitting the appropriate samples to a veterinary diagnostic laboratory.

10.7 Investigating vaccination failure

After chickens have been vaccinated, the extension worker or livestock officer may receive reports of illness or death in vaccinated birds. In most cases, the farmers will blame the vaccine and, unless such reports are investigated thoroughly and the reasons for the apparent failure of vaccination are established and discussed with the farmers, the success of future vaccination campaigns may be at risk.

Vaccination failure occurs when the chickens do not develop adequate antibody titres following vaccination and/or are susceptible to field disease. Many factors may be responsible for the apparent failure of the vaccine to protect the chickens: some are related to the vaccine, others to the way the vaccine was handled and administered, while others are associated with the chicken itself.

To help work out the cause of the apparent vaccination failure, ask the farmer or vaccinator to describe the problem. The following questions can be posed:

- How many birds are sick or have died?
- What signs did they show?
- Are any birds still sick? (examine them if possible)
- Are any of the neighbours' chickens sick?
- What vaccine was used? (Does the farmer still have the vaccine bottle?)

If the farmer's chickens were vaccinated using ND vaccine and show signs of another disease, for example fowl pox, then it is most likely that the vaccine is not responsible for the disease. Once ND has been controlled in a flock, other diseases may become more apparent.

If the farmer's chickens were vaccinated using ND vaccine and show signs of ND, then further investigation is necessary. Ask the farmer:

- What vaccine was used? (Does the farmer still have the vaccine bottle?)
- When were the birds vaccinated?
- When did the chickens get sick?
- Were all the birds in the flock vaccinated?
- How was the vaccine given to the chickens?
- How was the vaccine stored?

If the farmer or vaccinator still has the vaccine bottle, read the label and record the name of the vaccine, its batch number and expiry date, and note any information about how it should be given. If the vaccine was given by dropper, ask the farmer if they still have the dropper.

Have you seen or used this vaccine previously? In some countries, counterfeit vaccines may be on the market and, if used, will not protect the chickens. Their sale should be reported to the authorities.

If the vaccine is one you have encountered before, was it used within the expiry date? Vaccine used after it has expired cannot be relied on to protect chickens.

If the vaccine is one you have encountered before and it was used within the expiry date, was the vaccine correctly conserved before it was used? How was it stored? Most vaccines require a good cold chain to retain their activity. Only thermotolerant vaccines such as NDV4-HR and I-2 ND vaccines will withstand short periods outside a cold chain.

If the vaccine was given to the chickens by any route other than that recommended by the manufacturer, or a diluent other than that recommended by the manufacturer was used, it is likely that the bird will not develop the expected long-lasting level of immunity.

If the vaccine was given to the chickens using a dropper or by any means other than that recommended by the manufacturer, check the number of drops delivered by the dropper (or return the dropper to the manufacturer for testing). If the chicken has not received an adequate dose of vaccine, it is likely that it will not develop the expected long-lasting level of immunity.

If the chickens became sick within 7 days of vaccination and other birds in the village are showing signs of ND, then it is most likely that the chickens were incubating ND at the time of vaccination and the vaccine cannot be expected to be effective.

If it is more than 4 months since the chickens were vaccinated and they are showing signs of ND, then it is most likely that their level of immunity has decreased and revaccination is necessary.

Finally, birds that are stressed, malnourished, immunosuppressed due to diseases such as IBD/Gumboro or Marek's disease, or have severe parasitic infections, are unlikely to develop good immunity following vaccination.

10.8 Controlling Newcastle disease

There is no known cure for ND and it cannot be controlled in villages without vaccination. Vaccination should be accompanied by good hygiene (keeping sanitary rules) and other general measures as described in Section 9.3.

Newcastle disease control combined with improved husbandry is often the most cost-effective means of improving village chicken production.

10.8.1 Newcastle disease vaccination

Several different vaccines have been developed to prevent ND (Table 13). This manual deals mainly with a vaccine called I-2, which was specially developed to cope with situations where it is difficult to store and keep vaccines cold.

> **Note:**
>
> The example given below to explain how a vaccine works should be understood in most areas and by people who have limited scientific knowledge about how disease occurs. If you think that the story below may not be well received in a certain area, then please prepare an alternative explanation before the training session.

Giving a vaccine to a bird is like training soldiers to defend an area. The chicken can be thought of as the land to be protected, the vaccine contains the soldiers and the ND particle (virus) is the enemy. The soldiers first have to practise how to fight and to learn about the enemy so that they can win the battle. When soldiers arrive in a new area that needs to be protected, they must establish their lines of defence and collect information about the enemy that is causing problems.

When we give the vaccine to the bird, the bird's defence system is trained to recognise the ND virus as an enemy and establishes lines of defence against it. It takes around 7–14 days for the chicken to develop these lines of defence. The next time that the bird encounters the strong virus, the defence lines are already in place and so the strong virus cannot take over the bird's body. The headquarters for the soldiers lies just behind the chicken's eye and so when the vaccine is given by eye-drop, most of it goes straight to this centre. This is why eye-drop administration causes so strong a protective response.

Table 13. Comparison of Newcastle disease vaccine types

Vaccine	Thermotolerance	Type	Source	Administration	Period of protection
I-2	Thermotolerant	Live	Locally produced or imported	Eye-drop, water supply	4 months
NDV4-HR	Thermotolerant	Live	Imported	Eye-drop, water supply	4 months
La Sota	Thermolabile	Live	Imported	Eye-drop, water supply	4 months
Hitchner B1	Thermolabile	Live	Imported	Eye-drop, water supply	4 months
ITA-NEW	Thermotolerant	Inactivated	Imported	Injection	6–12 months

When soldiers stay in one place without seeing the enemy for a long time they may get lazy and think that the enemy is not going to attack. If the soldiers forget to maintain their lines of defence, then the enemy could attack and defeat the soldiers. It is the same with vaccine. If we do not re-vaccinate birds every 4 months, the birds' lines of defence against ND will get lazy and will be unable to fight the strong virus successfully.

- **Thermolabile vaccines.** Thermolabile vaccines are very temperature-dependent and should be used within a short time of being removed from the refrigerator. They will be ineffective if left outside of the refrigerator for longer than the time recommended by the manufacturer.
- **Thermotolerant vaccines.** Thermotolerant vaccines are more tolerant to higher temperatures and can remain active outside of the refrigerator for longer periods. However, thermotolerant vaccines should still be handled with care and kept as cool as possible.
- **Type.** Live vaccines result in a wider range of immune responses in the bird than do inactivated vaccines, which is an advantage. However, live vaccines stimulate a shorter period of immunity.
- **Source.** Locally produced vaccines are made to suit local conditions and the revenue from their sale stays within the country.
- **Administration.** Injectable vaccines are more expensive to administer than vaccines delivered by eye-drop or via the chickens' water supply, since they require skilled and experienced operators. (There is also the risk of needle-stick injuries to humans, which is exacerbated in conditions where blood-borne diseases such as HIV/AIDS are prevalent.)
- **Period of protection.** Inactivated ND vaccines (e.g. ITA-NEW) provide a longer-lasting protection than the other vaccines. However, in a village environment, chicks are constantly hatching throughout the year. Under these circumstances it is better to administer the vaccine more regularly to adequately cover newly hatched birds. The 4-month protection period provided by live vaccines is therefore suitable for village chickens as flocks should be vaccinated at least three times per year. This is particularly so where ND outbreaks are not restricted to a certain season.

10.8.2 Storing and transporting the I-2 vaccine

The length of time that the I-2 vaccine can be stored inside or outside a refrigerator will vary from country to country according to the method used to prepare and transport the vaccine (e.g. Table 14). The leaflet provided with the vaccine will give recommendations for storage times and conditions. When you obtain a container (it might be a vial or an eye-dropper) of vaccine, always read the label. It is important to know how to store the vaccine and how long it can stay effective outside the refrigerator before and after the container is opened.

Here are some general points for guidance:

- I-2 ND vaccine can keep its activity even if it stays outside the refrigerator for some time, but it must not be exposed to sunlight or allowed to get hot!
- Do NOT freeze the vaccine or put it into areas where ice forms. The vaccine does not tolerate very cold conditions.
- Try to keep vaccine at a constant temperature. The vaccine will lose some of its activity with each change in temperature. When you store the vaccine in a refrigerator, do not place it in the door since it will be exposed to changes in temperature every time the refrigerator is opened.
- If the vaccine is placed in a reliable refrigerator (4–8 ºC), it will last until the expiry date on its label. However, once the vaccine has been removed from the refrigerator and allowed to warm, it will lose its activity before the expiry date.
- Transport the vaccine in the field using a cool box and ice pack if they are available. If they are not available, wrap the vial in a damp cloth and carry it in a covered, open-weave basket or any other container that allows the air to pass through in order to keep the vaccine cool and away from sunlight (Figure 34). An open-weave basket and a damp cloth will keep the vaccine cooler than a cool box without ice packs.
- Once the vial has been opened, it will last longer if it is kept cool (around 22 ºC) but it should be used as quickly as possible.

Table 14. Storage guidelines prepared using thermostability trial data and provided to users of I-2 vaccine in Mozambique

Storage temperature	Safe storage interval	
	Freeze-dried vaccine	Wet vaccine
9–30 °C	2 months	2 weeks
Above 30 °C	2 weeks	2 days

- Outside a refrigerator, the unopened vaccine will last for 2 weeks as a ‘wet’ vaccine and 2 months in freeze-dried form if stored in a cool (around 22 °C or less), dark place. In villages, consider placing the vaccine container near the base of a clay water pot that is kept in a clean, dark place. The vaccine should also be stored in a way that prevents children from playing with it. If the unopened vaccine is allowed to get hot (above 30 °C), it will last for only 2 days in the wet form and 2 weeks in the freeze-dried form.

Figure 34. A covered, open-weave basket with a damp cloth inside is a good way to transport thermotolerant vaccine in the field.

10.8.3 Vaccinating chickens

Vaccinating chickens in a regular and effective manner is a complex activity that requires high-quality training and monitoring. Details of these activities can be found in the companion manual 'Controlling Newcastle disease in village chickens: a training manual' (Alders et al. 2002).

Method of administration

It is recommended that I-2 vaccine be given by eye-drop, as the bird develops a stronger immunity when the vaccine enters via the eye. The vaccine can also be given via drinking water but birds then develop a weaker immune response. The vaccine must also be given more often if administered via drinking water and this makes vaccination more expensive. An additional problem is that the more aggressive birds may drink more water, resulting in the weaker birds receiving an inadequate dose of vaccine.

Some notes on eye-drop administration of vaccine follow:

1. Eye-drop vaccination is easier if at least two people (such as the farmer and the vaccinator), participate; one person can hold the chickens while the other vaccinates.
2. Check each chicken before vaccination to confirm that it is healthy. Sick chickens should not be vaccinated, as they will have a weaker immune response to the vaccine and so may still develop ND during an outbreak.
3. Birds should be out of direct sunlight when they are vaccinated (e.g. in the shade of a tree).
4. The dropper containing the vaccine should be held vertically above the chicken's eye.
5. Place one drop in the eye of the chicken (Figure 35). Do not touch the bird's eye with the tip of the dropper; a contaminated tip may transmit disease.
6. All healthy birds in a flock should be vaccinated (even newly hatched chicks).
7. To minimise the risk of spreading disease, wash your hands after visiting each flock and avoid walking in chicken droppings.

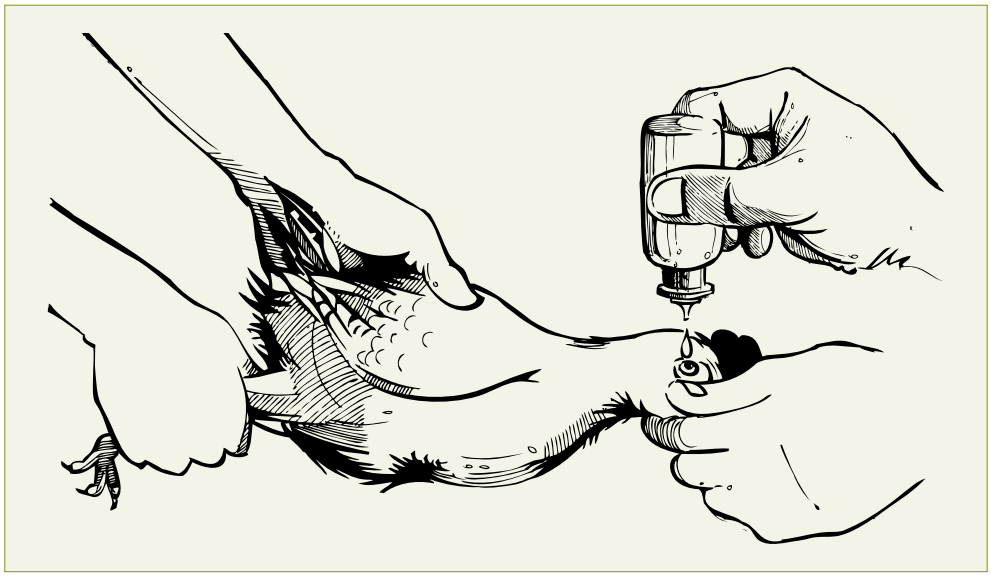

Figure 35. When using an eye-dropper to administer Newcastle disease vaccine, hold it in a vertical position. Do not touch the eye with the tip of the dropper.

10.9 Reporting Newcastle disease

Newcastle disease is one of the most devastating diseases of chickens, and a combination of strict sanitary measures and vaccination is required to control it. Control measures for diseases such as ND are generally laid down in national control strategies and, because of their economic importance, the diseases are **notifiable**; that is, **every outbreak of ND must be reported to the local veterinary authorities** who will report it to the appropriate national and international authorities.

To ensure accurate reporting, the diagnosis of ND has to be as reliable as possible. Ideally, isolation and characterisation of ND virus should be performed at every primary outbreak. However, this is not practical under village conditions and a case definition has been formulated for ND (see Section 10.6). All cases that meet this definition should be considered as possible outbreaks of ND and followed up by further diagnostic procedures as described in Section 8.5.

10.10 Differential diagnosis of Newcastle disease in village chickens

Newcastle disease can produce a range of signs in chickens, depending on the body system or organs affected. It therefore has to be distinguished from other diseases that affect the same body system or organs (see Table 12) and cause similar clinical signs or high mortality in chickens.

To assist extension workers in the diagnosis and differential diagnosis of ND at village level, Table 15 summarises common diseases of village chickens according to the body system or organ and age group affected.

Table 15. Differential diagnosis of common diseases of village chickens

Body system	Age group	Disease
Respiratory system	All age groups	Newcastle disease (ND)[A] Chronic respiratory disease[B] Infectious coryza[B] Mycoplasmosis[B] Infectious bronchitis[A] Highly pathogenic avian influenza (HPAI)[A]
	Chicks	Aspergillosis[C]
	Growers, adults	Laryngotracheitis[A] Fowl cholera[B] (chronic form)
Digestive system	All age groups	ND[A] HPAI[A] Colisepticemia[B] Infestation with helminths (usually more of a clinical problem in young birds)[D]
	Chicks	Pullorum disease[B] Infectious bursal disease/Gumboro[A] Coccidiosis[D]
	Growers	Fowl typhoid[B] Coccidiosis[D]
	Adults	Fowl typhoid[B]
Central nervous system	All age groups	ND[A] HPAI[A]
	Chicks	Vitamin E deficiency[E]
	Growers, adults	Marek's disease[A]
Skin	All age groups	Fowl cholera[B] Infestation with external parasites[D]
	Growers, adults	Fowl pox[A]
Urogenital system	All age groups	Infectious bronchitis[A]
Musculoskeletal system	All age groups	Infectious synovitis[B] (mycoplasmosis) Fowl cholera[B] (chronic form)
	Chicks	Riboflavin (vitamin B) deficiency[E] Vitamin E deficiency[E] Vitamin D3 deficiency (rickets)[E]
	Growers	Marek's disease[A]
	Adults	Marek's disease[A] Avian tuberculosis[B]
Eggs	Hens	ND[A] Infectious bronchitis[A] HPAI[A]

[A] Viral infection (cannot be treated)

[B] Bacterial infection (can be treated using effective antibiotics)

[C] Fungal infection (treatment possible but seldom successful)

[D] Caused by parasites (can be treated using effective antiparasitic drugs)

[E] Nutritional deficiency (can be treated by improving diet)

11 Other infectious diseases of village chickens

11.1 Introduction

Once ND is under control, other diseases that previously had little impact on the village chicken population will probably become more prominent. It is thought that the periodic severe outbreaks of ND that wipe out the whole flock also wipe out the pool of infection for other diseases. With effective ND control, increased flock sizes provide numerous hosts for any infectious agent, and increased trade in chickens and eggs might also contribute to the spread of infectious diseases.

Diseases related to poor nutrition might also become more important, since only a limited number of chickens may be able to obtain a balanced diet from the scavenging feed resource base (see Section 2.4).

In the south-eastern region of Africa, fowl pox appears to be the biggest potential problem, while in some parts of Asia, fowl cholera is widespread. Both diseases might gain importance once ND is under control but, because they have different methods of transmission, it is unlikely that either of them would ever become as severe as ND. Neither fowl cholera nor fowl pox spread over large areas or as quickly as ND. Apart from HPAI, this also applies to other diseases of village chickens.

Brief descriptions of a number of infectious diseases reported in village chickens are presented here. The diseases include those that should be considered in the differential diagnosis of ND, and those that might gain importance once ND is controlled.

The **clinical signs** and **post-mortem lesions of each disease are described**, as are **the cause, susceptible species** and ways of **transmission**, in order to show how the disease **spreads** and what are effective **control** mechanisms. Chapter 9 gives general information on prevention and control of infectious diseases. The notes provided here should be considered as a guide and, wherever possible, appropriate technical assistance should be sought to confirm diagnoses.

The diseases in this chapter are covered in alphabetical order regardless of their impact on village chicken production. Table 16 lists the diseases, grouping them according to whether the causative agents are viruses, bacteria, fungi, mycoplasmas, or internal or external parasites.

Table 16 **Poultry diseases grouped by causative agent, with the section in which they are covered this manual indicated**

Causative agent	Common name of disease	Section
Viruses		
Paramyxovirus	Newcastle disease	10
Influenza A virus	Avian influenza (fowl plague)	11.2
Poxvirus	Fowl pox	11.8
Birnavirus	Infectious bursal disease (IBD)/ Gumboro disease	11.10
Coronavirus	Infectious bronchitis	11.11
Herpesvirus	Infectious laryngotracheitis	11.13
Herpesvirus	Marek's disease	11.14
Bacteria		
Escherichia coli (with *Mycoplasma gallisepticum*)	Chronic respiratory disease	11.3
E. coli	Colisepticaemia	11.5
Pasteurella multocida	Fowl cholera (pasteurellosis)	11.7
Salmonella gallinarum	Fowl typhoid	11.9
Salmonella pullorum	Pullorum disease (bacillary white diarrhoea)	11.15
Haemophilus paragallinarum	Infectious coryza	11.12
Mycoplasmas		
Mycoplasma gallisepticum	Chronic respiratory disease	11.3
Internal parasites		
Coccidiosis	Coccidiosis	11.4
Ascaridia galli	Roundworms	11.16
Capillaria	Hairworms	11.16
Heterakis	Caecal worms	11.16
Tapeworms	Tapeworms	11.16
Gapeworms	Gapeworms	11.16
External parasites		
Echidnophaga gallinacea	Stickfast flea	11.6.1
Chicken lice	Lice	11.6.2
Knemidocoptes mutans	Scale leg mites	11.6.3
Epidermoptes bilobatus *Ornithonyssus sylviarum* *Ornithonyssus bursa* *Dermanyssus gallinae*	Skin mites	11.6.4
Ticks	Ticks	11.6.5

11.2 Highly pathogenic avian influenza (fowl plague)

Cause

Avian influenza is caused by influenza A virus. Influenza viruses can change their strength by mutation and re-assortment. Different subtypes of the influenza virus with reduced strength might not always cause a clinical disease. The very contagious and severe form of avian influenza is known as highly pathogenic avian influenza (HPAI).

Transmission

Influenza virus is shed in the droppings of, and any discharge from, infected birds. Although the virus can readily be destroyed by direct sunlight or heat, it may survive for several weeks in a pile of droppings.

The disease spreads:

- by direct contact between birds or contact with wild birds (agents in discharges and droppings are inhaled by other birds)
- by intake of contaminated feed or water
- between flocks, in infected dust particles
- on the shoes or clothes of people or on equipment (e.g. egg trays and cages).

Epidemiological studies in Thailand indicate that village flocks are at lower risk of HPAI infection than are small-scale and commercial-scale operations of broiler or layer chickens or quail.

Species affected

A wide variety of domestic and wild birds is susceptible, although clinical signs are observed mainly in chickens and turkeys. Ducks and geese may carry the virus without showing any signs.

Highly pathogenic avian influenza may affect humans, causing severe respiratory disease or even death.[2]

Clinical signs

Clinical signs may occur within a few hours of infection and vary depending on the subtype of virus. Highly pathogenic avian influenza may wipe out a whole flock within days. Signs include:

- sudden death with few clinical signs
- ruffled feathers
- inappetence (not eating)
- distressed and noisy breathing, coughing and sneezing
- discharge from the eyes or nose

2 Under some conditions, the influenza virus can spread from ducks or chickens and adapt to other hosts. Pigs play an important role as hosts for some subtypes of the virus (but not H5N1) that originate in poultry and may affect humans.

- swelling of the face, including combs and wattles
- drop in egg production
- soft-shelled eggs
- diarrhoea
- small haemorrhages under the skin (i.e. bruising; usually most visible on feet and legs)
- lameness
- twisted neck and tremors
- at least half of the flock dies within one week (50–100% mortality).

Incubation period

It is important to remember that immediately following infection a bird will appear healthy while the disease is in the incubation period. The incubation period for an individual bird is usually 2–7 days, depending on the strain of virus involved, the dose of virus received, and the species and age of the bird. In the case of HPAI H5N1, the incubation period is usually 2–5 days. The onset of severe disease in a flock of birds can take up to 18 days (Figure 36), especially in caged layers.

Post-mortem findings

If HPAI is suspected, it is important that personal protective equipment (PPE) be used if a post-mortem is conducted and that the post-mortem be done in a safe area away from the general public.

Post-mortem lesions are non-specific and include:

- small haemorrhages in lungs, air sacs, intestines, pancreas and heart
- small amounts of cheesy material between the intestines and on the liver and heart
- mucus or even bloody content in the trachea, sinuses and perhaps in the nasal cavity.

If birds died quickly, gross lesions may not be found.

Diagnosis

Avian influenza cannot be diagnosed on the basis of clinical signs alone. The diagnosis can be confirmed only by laboratory examination to confirm presence of the virus or, in certain circumstances, to detect specific antibodies to the virus.

Highly pathogenic avian influenza should be suspected when there is high mortality in chickens that have been vaccinated against ND within the previous 4 months.

Differential diagnosis

The differential diagnosis of HPAI varies according to the poultry production system (Table 17).

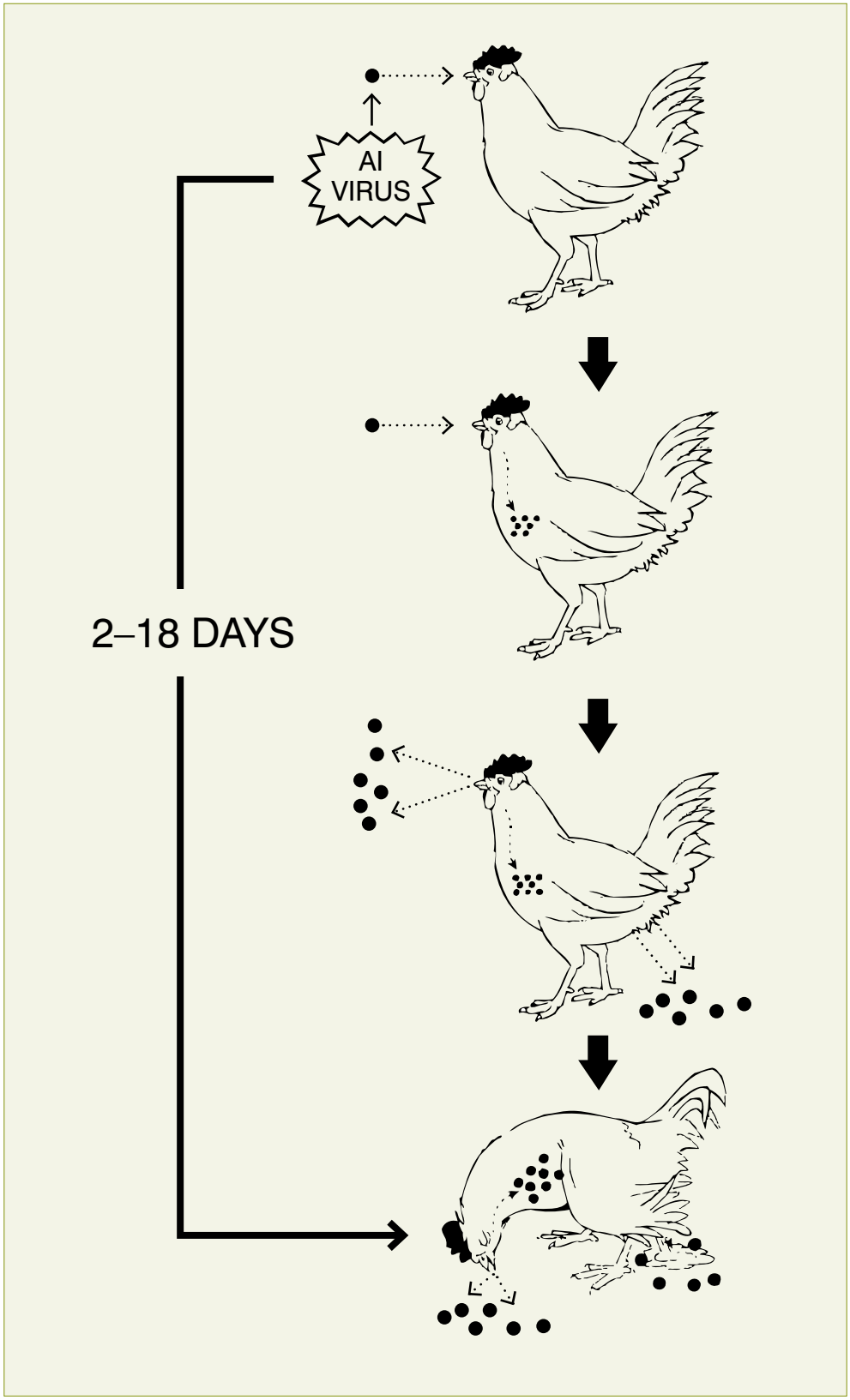

Figure 36. The development of clinical signs of avian influenza (AI) in a flock can take 2–18 days. Note that an infected bird can spread virus before it starts to show signs of sickness.

Table 17. Diseases other than highly pathogenic avian influenza that cause sudden high mortality or swelling of combs and wattles in chickens, grouped by production system

Clinical signs	Intensive production	Extensive production
Diseases causing sudden high mortality	Newcastle disease Infectious laryngotracheitis Infectious bursal disease/Gumboro disease Acute fowl cholera Duck plague (duck virus enteritis) Acute poisonings	Newcastle disease Acute fowl cholera Duck plague (duck virus enteritis) Acute poisonings
Diseases causing swelling of combs and wattles	Acute/chronic fowl cholera and other septicaemic diseases Bacterial cellulitis of the comb and wattles	Acute/chronic fowl cholera and other septicaemic diseases Bacterial cellulitis of the comb and wattles

Action plan for when HPAI is suspected

If you suspect a case of HPAI, remain calm and implement the guidelines provided by your local veterinary services. If you do not have guidelines available, the following actions should be implemented as quickly as possible. Quick and appropriate actions can prevent the spread of the disease.

1. Speak with the farmers, village leaders, health officials and nearest police officers to ensure that:
   (i) the affected flock(s) is isolated and quarantined
   (ii) all movement of poultry and pigs from the village stops immediately
   (iii) other flocks of poultry in the village are confined as much as possible.
2. Send an urgent message to the relevant veterinary authority asking them to come and investigate the outbreak.
3. Children, the elderly and sick people should have no contact with sick or dead birds. Any people who have been in contact with sick, dying or dead birds should be monitored for signs of illness and any illness reported to the medical services.

Avian influenza in humans should be suspected where an individual has:

- a body temperature of over 38 °C
- at least one of the following signs—muscle pain, cough, breathing difficulty, or shortness of breath
- has been in direct contact with sick or dead poultry in the preceding 7 days, lives in an area where unusual poultry deaths have been reported in the last 14 days, or has been looking after a pneumonia patient in the 10 days before the onset of the illness.

4. Sick and dead birds should not be eaten by people or predators. They should be buried or, if they cannot be buried, burnt. When burying in a pit, place 40 cm of soil on top of the carcasses, followed by a layer of agricultural lime or wood ash, then complete filling in the pit with more soil. Lime should not be placed directly on the carcasses as it slows decomposition.
5. Remind villagers to wash their hands with soap frequently. Clothes and items (e.g. water containers, feeders, cages etc.) that have come into contact with sick or dead birds should be dealt with in one or other of the following ways:
   (i) put in a pile to await the arrival of the investigation team—place lime or wood ash under and over the pile
   (ii) washed with detergent or disinfectant—contaminated clothing and equipment should not be washed near water sources used by the community or water birds
   (iii) boiled in water for 5 minutes.
6. Together with the villagers, identify a site suitable for the construction of a pit for the disposal of carcasses away from community wells and watercourses. In collaboration with the village leader, arrange for one or more pits to be dug.
7. Collect a history of the movement of birds (including both domestic and wild birds) in the area over the previous month to inform the investigating team. Record when the last vaccination campaign against ND was conducted and which farmers participated in the campaign.
8. If you have PPE issued by the veterinary authority, collect the dead birds into a central location on each farm or around each house where dead birds are located. Remember to disinfect your boots before you move between contaminated locations.
9. If you do not have appropriate PPE, work with community leaders and local authorities to restrict the movement of people and animals onto the farm or area where the dead birds are located and wait for the investigation team to arrive.
10. Remember that high concentrations of HPAI virus can be present in the droppings (i.e. manure) of infected birds. Special care should be taken when handling manure or material contaminated with manure.

Prevention

Section 9.3 provides general advice on the prevention of disease in village flocks. In countries free of HPAI it is important that:

- border inspection services conduct regular surveillance
- the legislation on trade in wild birds is enforced
- the legislation on movement of poultry and poultry products is enforced
- groups of poultry traders be formed and training conducted on HPAI and how it can it be prevented and controlled
- meetings are held with owners of fighting cocks to raise their awareness of the risk from HPAI, with special emphasis on border areas.

Control

Avian influenza cannot be cured. Avian influenza is a **notifiable disease** because of its immense impact on poultry-keeping systems and potential impact on human health, and outbreaks must be reported to the veterinary authorities.

Initial response

Early detection of outbreaks is essential for the control of HPAI.

Following a confirmed laboratory diagnosis of HPAI, all birds on infected commercial farms, in infected village flocks and in high-risk contact areas are culled. This should be done rapidly and efficiently, in accordance with the national contingency plan. Good records must be kept to facilitate the payment of compensation to farming families.

Heavily contaminated manure represents a special problem in efforts to control influenza. Litter and manure can be disposed of by burial or rendered safe by composting in a pile covered with plastic.

Widespread outbreaks

Should HPAI spread and become endemic, then veterinary authorities may introduce the vaccination of poultry. The selection of the vaccine should be done in accordance with international FAO/OIE guidelines.

Vaccinated birds can still spread highly pathogenic avian influenza

Vaccinated birds can still be infected with virulent strains of HPAI and shed virulent virus without showing clinical signs of disease. However, the amount of virus shed will be less than that from non-vaccinated infected birds.

Disinfection

Soaps and disinfectants can inactivate the virus on contact with it. The strength and freshness of the disinfectant solution will influence the time required for virus inactivation, and so the manufacturer's instructions should be followed closely. The presence of organic material will reduce the effectiveness of disinfectants and so it is important to remove as much soil and manure as possible from cages, feeders, vehicles etc. before doing the final disinfection. Organic material removed from contaminated premises should be buried or composted.

Agricultural lime (i.e. powdered lime) and wood ash will inactivate the virus and are especially useful in chicken houses with earthen floors. The powdered lime or wood ash should be placed on the earthen floor and allowed to remain there for at least 2 days.

The difference between antiseptics, disinfectants and antibiotics

Antiseptics are physical or chemical agents that kill or inhibit the growth of micro-organisms on the external surfaces of the body. Some common antiseptics are alcohol, iodine, hydrogen peroxide and boric acid. **Germicides** are antiseptics that *kill* micro-organisms.

There is great variation in the ability of antiseptics to destroy micro-organisms, and in their effect on living tissue. Mercuric chloride, for example, is a powerful antiseptic, but it irritates delicate tissue. In contrast, silver nitrate kills fewer germs but can be used on the delicate tissues of the eyes and throat. There is also a great difference in the time required for different antiseptics to work. Iodine, one of the fastest-working antiseptics, kills bacteria within 30 seconds. Other antiseptics have slower, more residual action.

Disinfectants are agents which destroy micro-organisms found on non-living objects. Some common disinfectants are Virkon®, 70% alcohol and washing soda.

Antibiotics are agents that are used to treat infections in people and animals caused by bacteria and other micro-organisms.

Source: <http://www.biology-online.org/dictionary/Antibiotic> and 'The Columbia electronic encyclopedia', 6th ed.

Public health

People may be infected with avian influenza virus. In general, those infected with the currently circulating strain of H5N1 HPAI virus have suffered severe respiratory disease, and death has occurred in over 50% of reported cases.

The emergence, by re-assortment or mutation, of a highly pathogenic strain of influenza A which could transmit between people to cause a global pandemic is a matter of the gravest international concern. The most effective means of protecting human welfare is to combat the precursor virus in its avian hosts so as to prevent the opportunities for infection of other species and emergence of a pandemic strain.

Do not inhale the highly pathogenic avian influenza virus

Very poor protection: A cotton scarf tied over the nose will filter out approximately only 10% of any virus particles that are present in the air.

Poor protection: A dust mask will filter out around 13% of virus particles.

Excellent protection: The N95 (or P2) protective mask supplied with the personal protective equipment kit will filter out 95% of virus particles.

11.3 Chronic respiratory disease

Cause

Chronic respiratory disease (CRD) is caused by several infectious agents that affect the respiratory tract. In general, *Escherichia coli* and a bacteria-like organism called *Mycoplasma gallisepticum* are involved, but the infection is often complicated by chronic stress and the presence of other bacteria or viruses.

Transmission

The agents are shed in discharges from the eyes and nose of infected birds and can survive outside a bird (in droplets of discharge) for up to 3 days.

The disease is spread:

- by direct contact between birds (agents in discharges may be inhaled by other birds)
- via the air (but not over long distances)
- by carrier birds (chickens that have recovered from CRD can shed the causative agents for a long time)
- via the egg from infected hens to their chicks (i.e. vertical transmission).

Species affected

Chronic respiratory disease affects chickens, guineafowl, turkeys and other birds

Clinical signs

Clinical signs of CRD may be observed as early as 1 day after infection and are long lasting. Normally CRD spreads slowly through a flock causing mild respiratory disease characterised by:

- discharge from nose and eyes
- coughing or sneezing
- respiratory sounds
- swollen head
- reduced egg production.

A few birds may die. Signs may be more severe if the chickens are already suffering from other diseases.

Post-mortem findings

Post-mortem evidence of CRD includes:

- mucus in the trachea and sinuses
- reddish trachea
- thickened air sacs with cheesy content.

Control

Chronic respiratory disease can be treated using antibiotics but the disease may recur after treatment ends.

Chapter 9 provides general information on the prevention and control of infectious diseases.

11.4 Coccidiosis

Cause

Coccidiosis is caused by microscopic protozoan parasites called coccidia. In chickens there are several different coccidian species belonging to the genus *Eimeria* that may affect various parts of the intestine.

Transmission

Coccidia are shed in the droppings of infected birds and, in humid or wet environments, they can survive for up to a year. Other birds are infected by eating the coccidia.

The disease is spread:

- by contact with infected droppings
- by contact with feed or water that has been contaminated by faeces
- on the shoes or clothes of people or on equipment.

Species affected

Domestic poultry and birds are affected by coccidiosis. The species of *Eimeria* that affect poultry are host-specific, meaning that a species that infects chickens does not infect, for example, turkeys and vice versa.

Clinical signs

Coccidiosis can affect all age groups but is most serious in young birds, in which mortality rates can be as high as 50%.

Clinical signs can be seen 4–6 days after infection and are characterised by:

- depression and listlessness
- diarrhoea
- loss of weight
- bloody droppings (in some cases)
- a pale comb.

Post-mortem findings

Post-mortem evidence of coccidiosis includes:

- lesions (grey–whitish patches, small haemorrhages) in the affected part of the intestines

- cheesy or mucous content in the intestines
- ballooning of the intestines.

Control

Infected flocks may be treated with coccidiostats if available. Nevertheless, the use of such agents without further measures to reduce the risk of re-infection will provide only a short, temporary improvement.

The most effective control measure is to minimise the risk of infection by keeping the number of coccidia in the chickens' environment as low as possible. The improvement of housing conditions (as described in Chapter 4) will greatly help in the control of coccidiosis: to minimise re-infection, remove the droppings daily, keep the chicken house clean and dry, and avoid overcrowding.

Chapter 9 provides general information on the prevention and control of infectious diseases.

11.5 Colisepticaemia

Cause

Colisepticaemia is caused by a bacterium called *Escherichia coli*. Other infectious agents and non-infectious factors (particularly poor husbandry) may predispose the bird to infection.

Transmission

The causative agent is shed in the droppings.

The disease spreads:

- by direct contact between birds (agents in the droppings may be inhaled by other birds)
- via the air
- by contact with contaminated feed or water
- on the shoes or clothes of people, or on equipment
- via the egg from infected hens to their chicks. This is common and may cause high chick mortality.

Species affected

All types of birds can be affected. The disease is reported most commonly in chickens, turkeys and ducks, but may also occur in guineafowl.

Clinical signs

Clinical signs may be seen 1–2 days after infection, mainly in young chicks, and include:

- weakness
- diarrhoea
- emaciation in growers

- lameness in growers (occasionally)
- heavy breathing in growers (occasionally).

Older chickens are better able to fight this disease, provided they are in good health and have good nutrition.

Post-mortem findings

Post-mortem evidence of colisepticaemia includes:

- remnant egg yolk (persistent yolk sac) in the body cavity of young chicks
- fine cheesy layer on the intestines, liver and heart.

Control

Treatment using antibiotics is possible. Since the quality of husbandry practised plays an important role in the occurrence of colisepticaemia, improved husbandry and sanitary measures, as described in chapters 4 and 9, are very important in control of this disease.

Public health

While the organism is essentially specific to birds, there is a very low risk of people and other animals contracting the disease.

11.6 External parasites (fleas, mites etc.)

Infestation with external parasites is a common problem in free-range systems. High levels of infestation irritate the birds and cause scratching, preening, reduced productivity and sometimes anaemia. External parasites can also transmit infectious diseases such as fowl pox.

The most common external parasites (Figure 37) are described in this section so that extension staff will be able to identify the causative agents and control infestations.

General control measures:

- Remove bark from timber used in the chicken house so that parasites cannot hide underneath.
- Avoid crowded housing.
- Clean the shelter and the nests regularly and thoroughly; all bedding, litter and droppings must be removed.
- Spread ash or agricultural lime on the floors and walls of chicken shelters and nests.
- Use smoke to fumigate shelter and nests regularly.
- In the case of severe infestation, the chicken house and nests should be burnt and a new house built at a different location.
- Allow the chickens to bathe in fire ash.
- Use an insecticidal dusting powder or spray if available.

Remember:

- all birds must be treated at the same time otherwise parasites from untreated birds will soon spread back to the birds you have treated
- apply insecticidal spray or powder to the nests and the chicken house as well, since ticks, some mites and fleas do not live constantly on the bird
- repeat the treatment after 1 week. (Insecticides do not kill the eggs of mites. In the eggs, young mites develop within 1 week.)

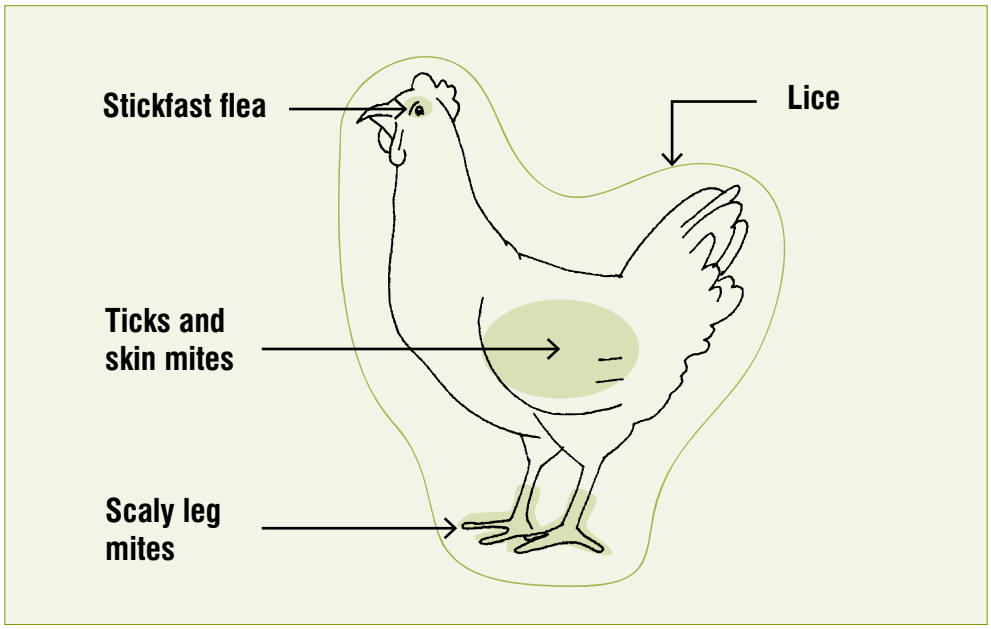

Figure 37. Diagram showing the areas on the body where different types of external parasites of chickens are most likely to be found

11.6.1 Fleas

The most common flea found on chickens in tropical and subtropical areas is the stickfast flea (*Echidnophaga gallinacea*), a small, dark parasite that sticks in clusters to the skin of the bird's head (mainly around the eyes).

The eggs and young of the stickfast flea are found in the surroundings of the chickens, where they feed on dry blood, faeces or other organic material. Adult fleas stay on the bird permanently and feed on blood. Stickfast fleas may survive for weeks without food.

Clinical signs

The following signs are typical of infestation with fleas:

- birds are irritated and restless, and may scratch at the eyes
- the skin, comb and wattles are pale due to blood loss
- there are crusted skin lesions where many fleas had stuck.

Chicks that are severely infested with fleas may die.

Control

To control fleas, the following steps should be taken:

- Kerosene, paraffin or petroleum jelly should be applied to the parasites several times a day (Figure 38). Within a short period, the fleas will die. Dead fleas might remain attached to the chicken for several days or even weeks.
- Brooding hens should be kept free from fleas to prevent infestation of young chicks.
- The general measures for control of external parasites (see above) should be adopted.

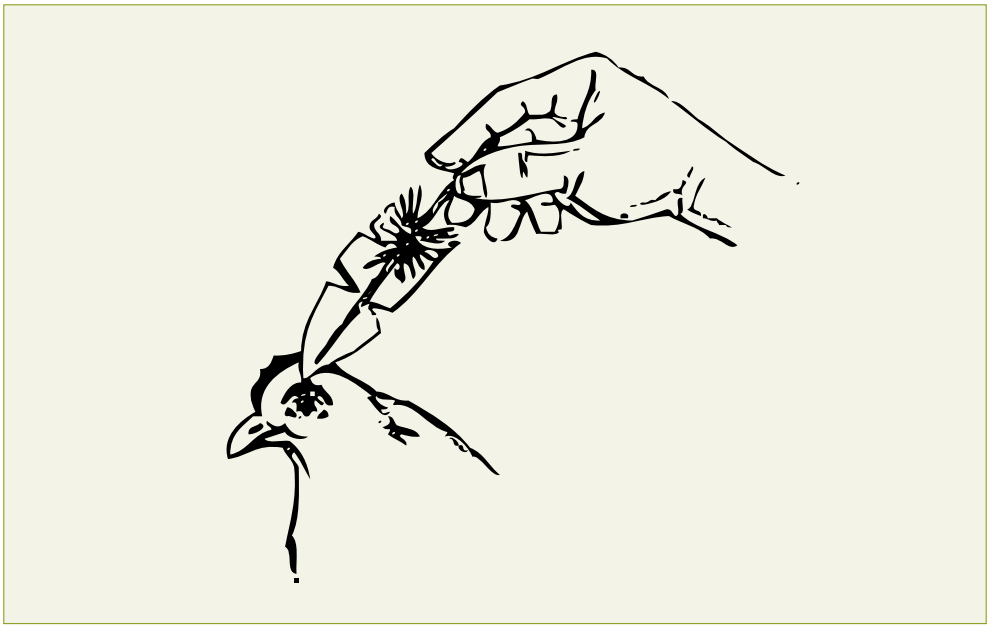

Figure 38. Application of paraffin to stickfast fleas using a feather

11.6.2 Lice

Lice are light yellowish-brown, cigar-shaped parasites of various sizes that can be found all over the body on the feathers. They stay permanently on the bird, and their small greyish eggs are attached in clusters to the feathers. Most lice feed on feathers; some species suck blood.

Clinical signs

The following signs are typical of infestation with lice:

- feathers are damaged
- birds may be irritated if the infestation is severe.

Control

The general control measures for external parasites (see above) should be followed.

11.6.3 Scaly leg mites

Scaly leg mites (*Knemidocoptes mutans*) burrow into and live in the skin on birds' legs and cause readily recognisable scales and deformation of the legs and feet.

Clinical signs

Chickens carrying scaly leg mites display thick scaly legs. In cases of severe infestation, lameness or malformation of the feet may occur.

Control

Scaly leg mites are difficult to treat. Soften the scales in water, then scrub them off and treat the legs with kerosene (also known as paraffin in some parts of the world), mineral oil (e.g. used engine oil; Figure 39), Vaseline or an insecticide. Repeat this procedure at least three times at weekly intervals. If it does not help, slaughter the bird.

In addition, the general control measures for external parasites should be followed.

Figure 39. Application of engine oil to a chicken leg infested with scaly leg mites

11.6.4 Skin mites

Skin mites (*Epidermoptes bilobatus*) are tiny (about 1 mm long), dark, fast-moving, blood-sucking parasites. They prefer those parts of the chicken's body with few feathers, such as the head and under the wings.

There are several types of mites. Species such as *Ornithonyssus sylviarum* and *O. bursa* remain permanently on the bird, whereas other species, such as *Dermanyssus gallinae*, hide in nests or cracks in buildings where birds are living and emerge to suck blood only at night. Skin mites can live up to 8 months without a blood meal.

Clinical signs

The following signs are typical of skin mite infestation:

- birds are irritated and become thin and weak
- productivity falls (hens might even stop laying eggs or brooding)
- the skin, comb and wattles are pale due to blood loss.

Severely infested birds, especially chicks, may die.

Control

To control skin mites:

- remove the bark from timber used to construct shelters (to reduce hiding sites for the mites)
- lime perches and structures
- follow the general control measures for external parasites (see above).

11.6.5 Ticks

Ticks are small, blue or brownish, blood-sucking parasites that can be found on the skin, especially in parts of the body with few feathers, such as the head and under the wings.

Off the bird, they live in cracks, under the bark of branches used to build shelters, walls or trees where they also lay their eggs. Nymphs usually feed at night and can survive without food for as long as 15 months. Adult ticks can survive for more than 4 years without feeding on the blood of a bird.

Clinical signs

The following signs are typical of tick infestation:

- birds are irritated and become thin and weak
- productivity falls (hens may even stop laying eggs)
- the skin, comb and wattles are pale due to blood loss.

Control

To control ticks:

- remove the bark from timber used to construct shelters (to reduce hiding sites)
- follow the general control measures for external parasites (see above).

11.7 Fowl cholera (pasteurellosis)

Cause

Fowl cholera is caused by a bacterium called *Pasteurella multocida.*

Transmission

The agent is shed in discharges and droppings of infected birds. It can survive up to 30 days in water or soil, but is destroyed by direct sunlight, heat and drying.

The disease spreads:

- by direct contact between infected birds (infective agents in discharges and droppings are inhaled by other birds or enter via wounds)
- by intake of contaminated feed or water
- by contact with infected wild birds or farm animals
- on the shoes or clothes of people or on equipment.

Species affected

All poultry species are susceptible to fowl cholera although chickens and turkeys are the most prone to clinical disease.

Clinical signs

Fowl cholera usually affects birds that are more than 6 weeks old. Birds get sick 2–10 days after contact with the causative agent.

The acute form of the disease causes **high mortality within a few days** and birds may show no clinical signs. Characteristic signs of chronic fowl cholera are:

- many birds are tired and weak
- ruffled feathers, decreased appetite
- bluish comb and wattles
- swollen face and wattles
- swollen joints
- fast, distressed breathing
- coughing and sneezing
- clear to yellow discharge from eyes and beak
- watery diarrhoea and dirty vent.

Post-mortem findings

Post-mortem indicators of fowl cholera include:

- small haemorrhages in the lungs, intestines and heart
- cheesy material between the intestines, and on the liver and heart
- fluid in the pericardial sac and abdominal cavity.

Control

Good flock management that includes barring entry of sick birds, and the quarantining of new birds is advised. If the disease cannot be quickly controlled, it is better to cull the entire flock.

Treatment using antibiotics is possible but mortality may reappear soon after treatment stops. Antibiotics that can be used include sulfur drugs in water (not recommended as they will affect the reproductive organs), oxytetracycline (Terramycin®), Aureomycin ®, novoviocin, lincomycin, spectinomycin in feed. Note that if these antibiotics are used, the withdrawal period is a minimum of 10 days before slaughter for consumption.

Vaccination is possible but does not always provoke good levels of protection. An inactivated vaccine using a local strain in an oil adjuvant can be produced by appropriately equipped laboratories. Village poultry should be vaccinated from 3 months of age onwards and best results are obtained when a booster is given 2 weeks after the first vaccination. Adequate flock protection can be achieved by conducting two campaigns of double vaccination (i.e. two vaccinations 2 weeks apart) per year.

Fowl cholera vaccine must be stored correctly

Inactivated fowl cholera vaccine must be stored at 2–8 °C, **not frozen**. If frozen, the walls of the fowl cholera bacteria will rupture releasing endotoxin that can result in the death of chickens following injection.

Chapter 9 provides general information on the prevention and control of infectious diseases.

11.8 Fowl pox

Cause

Fowl pox is caused by a poxvirus.

Transmission

The virus is contained in the characteristic scabs found on chickens affected by the disease. It can survive in dried scabs for months or years.

The disease spreads:

- via scabs which fall off the skin
- by direct contact between birds (The virus enters birds through skin wounds, via the eye or by inhalation. A rooster can transmit the disease by scratching and biting the hen while mating.)
- via insect bites (red mites, mosquitoes)
- on the shoes or clothes of people, or on equipment.

Species affected

Fowl pox affects chickens only (pox in other animals is caused by other types of poxviruses).

Clinical signs

Chickens of all age groups can be infected, but older birds are most commonly affected. The disease usually develops slowly over 2–3 weeks. Flock mortality is usually low but, in severe cases, up to half of the flock may die from fowl pox.

Wart-like lesions develop on the skin ('**skin form**') or inside the mouth ('**wet form**', '**diphtheric form**'). Lesions can also be found on other parts of the body, such as the cloaca, skin of the wings or legs, but typical are:

- yellowish to dark-brown lesions on the head, particularly on the comb and wattles and around the eyes
- yellow–white, cheesy-looking lesions inside the mouth and on the tongue, maybe also inside the trachea and oesophagus (these lesions can grow together and block the bird's throat, and some birds may die because they cannot eat and breathe).

Skin lesions usually heal in 2 weeks. Birds that have recovered from fowl pox are usually immune and rarely get the disease again.

Post-mortem findings

Post-mortem examination may reveal yellow–white lesions inside the oesophagus and trachea or in the cloacal region.

Control

There is no specific treatment for fowl pox. Vaccination is possible if the vaccine and cold chain facilities are available. Fowl pox vaccine is usually applied by the wing-web method to 4-week-old chickens. Vaccination produces a mild form of the disease and should be applied strictly in accordance with the manufacturer's instructions. Once the vaccine vial is opened, its contents must be used within 2 hours.

Birds with mild lesions may survive if well cared for (by providing shelter, feed and water).

Chapter 9 provides general information on the prevention and control of infectious diseases.

11.9 Fowl typhoid

Cause

Fowl typhoid is caused by a bacterium called *Salmonella gallinarum*.

Transmission

The agent is shed in the droppings and can survive several months in the soil, dust or bedding. It is destroyed quickly when exposed to direct sunlight.

The disease spreads:

- by direct contact between birds (via the beak or through wounds)
- by contact with contaminated feed or water
- on the shoes or clothes of people or on equipment
- from infected hens to their chicks via the egg.

Species affected

Chickens, turkeys and guineafowl can contract fowl typhoid, which mainly affects adult birds but can cause mortality as high as 26% in chicks during the first month of life.

Clinical signs

Many older birds are affected, but normally only a few die. Clinical signs, which develop 2–5 days after infection, are:

- yellowish diarrhoea
- listlessness
- rough feathers and drooping wings.

Post-mortem findings

Post-mortem indicators of fowl typhoid include:

- swollen liver, spleen and kidneys, with small haemorrhages
- small white spots in the liver, heart and sometimes the lungs
- in chronic cases, cheesy material between the intestines, on the liver and heart
- misshapen, grey–greenish follicles on the ovary.

Control

Treatment with antibiotics is possible but no antibiotic or combination of antibiotics has been found capable of eliminating infection from a treated flock. It is therefore best to kill birds that seem to be sick with fowl typhoid. If the bird is eaten inadvertently, it is unlikely to cause a problem provided that the meat was well cooked.

Chapter 9 provides general information on prevention and control of infectious diseases.

11.10 Infectious bursal disease/Gumboro disease

Cause

Infectious bursal disease (IBD)/Gumboro disease is caused by a birnavirus. Different strains of the virus are recognised and typing is required if control by vaccination is being considered.

Transmission

The virus is shed in the droppings and is very stable. It may survive up to 4 months in the environment.

The disease spreads:

- by direct contact between birds (agents are inhaled by other birds)
- by contact with contaminated feed or water
- on the shoes or clothes of people, or on equipment
- from infected hens to their chicks via the egg.

Insects may act as carriers.

Species affected

Chickens and turkeys are susceptible to IBD/Gumboro.

Clinical signs

While birds of all age groups are susceptible to IBD/Gumboro, **only birds between 3 and 12 weeks of age show clinical signs**. Signs develop 2–3 days after infection. They include:

- depression and listlessness
- birds huddling together
- pale skin
- diarrhoea and a dirty vent.

Depending on the strain involved, mortality can vary from 30% to 90%. Antibodies to IBD are frequently found in 30–40% of village chickens but clinical disease is rarely seen. (Note that the presence of antibodies indicates that the bird has been infected but does not necessarily that it became sick from the infection.)

Post-mortem findings

Post-mortem indicators of IBD/Gumboro include:

- haemorrhages under the skin and in the breast and thigh muscles
- pale kidneys
- an enlarged, gelatinous, bursa of Fabricius (an organ that is part of the bird's immune system) with bloody spots; at a later stage the bursa shrinks.

Control

There is no specific treatment for IBD/Gumboro. Vaccination is possible but not practicable under village conditions. Since there are various strains of IBD/Gumboro virus, if vaccination is considered, the causative strain must be determined to ensure that the vaccine specific to that strain is administered.

Chapter 9 provides general information on prevention and control of infectious diseases.

Birds between 3 and 12 weeks of age that survive the disease will be more susceptible to other diseases because of damage to their immune system.

11.11 Infectious bronchitis

Cause

Infectious bronchitis (IB) is caused by a coronavirus.

Transmission

The virus is shed with discharges and is readily destroyed outside the bird.

The disease spreads:

- by direct contact between birds (virus is inhaled by other birds)
- with infected dust particles from flock to flock
- on the shoes or clothes of people, or on equipment.

Species affected

Infectious bronchitis affects only chickens.

Clinical signs

All age groups are affected. While the disease is highly contagious and will affect almost all birds in a flock, it is most severe in young chicks in which it may cause many deaths.

Birds show clinical signs within 2 days of infection. While younger birds show mainly respiratory signs, hens often display only a drop in egg production. The following are signs typical of IB:

- Young chicks may die following severe respiratory distress.
- Young chickens may have heavy and noisy breathing, and have open beaks.
- Coughing and sneezing may be evident in young chickens.
- There is a drop in egg production.
- Deformed eggs with wrinkled and rough shells are laid.

Post-mortem findings

Post-mortem indicators of IB include:

- a red trachea containing mucus
- froth in air sacs
- a yellow, cheesy plug at the end of the trachea of younger chickens.

Virus subtypes that affect the kidneys and result in high mortality cause:

- pale, swollen kidneys
- white, sand-like material in the ureter (the vessel connecting the kidneys with the cloaca).

Control

Birds infected with IB subtypes causing renal damage should be protected from the cold and provided with electrolytes in the drinking water. This will lower mortality significantly. Vaccination is possible but not practicable under village conditions.

Chapter 9 provides general information on prevention and control of infectious diseases.

11.12 Infectious coryza

Cause

Infectious coryza is caused by a bacterium called *Haemophilus paragallinarum*.

Transmission

The agent is shed in discharges from the nose and eyes but can survive only a short time outside the bird.

The disease spreads:

- by direct contact between birds (agents are inhaled by other birds)
- by intake of contaminated feed or water
- with infected dust particles dispersing from flock to flock
- on the shoes or clothes of people, or on equipment
- by carrier birds (infected adult birds that are not showing signs but may introduce the disease into a new flock).

Species affected

Infectious coryza affects chickens, guineafowl and pheasants.

Clinical signs

Birds of all age groups are affected but the disease is generally more severe in older birds.

Clinical signs occur 1–3 days after infection. The disease can last from a few days to 2–3 months, although many birds show clinical signs that disappear after 14–21 days. Signs of infectious coryza include:

- distressed and noisy breathing
- sneezing
- a nasal discharge that is clear at first but later becomes yellowish and foul-smelling
- discharge from the eyes—the eyelids may stick together
- birds shaking their heads (to get rid of the discharge)
- swelling of the face.

Infectiouse coryza does not usually kill many birds, but feed and water intake are reduced and the birds lose weight.

Post-mortem findings

Watery discharges can be found in the nasal passages and sinuses of diseased birds.

Control

Infectious coryza can be treated using antibiotics such as oxytetracycline but drug resistance does develop. Relapse may occur following treatment. Commercial vaccine is available in some countries.

Avoid exposing birds to humid and cold conditions, which increase the severity of this disease.

Chapter 9 provides general information on prevention and control of infectious diseases.

11.13 Infectious laryngotracheitis

Cause

Infectious laryngotracheitis (ILT) is caused by a herpesvirus.

Transmission

The virus is shed with discharges and can survive in droppings and carcasses.

The disease spreads:

- by direct contact between birds (agents are inhaled by other birds)
- via the air
- by contact with contaminated feed or water
- on the shoes or clothes of people, or on equipment
- by carrier birds (which may carry the virus for life).

Species affected

Infectious laryngotracheitis affects only chickens.

Clinical signs

All age groups of chickens are affected but the most characteristic signs are seen in adult birds.

Clinical signs occur 6–15 days after infection and include:

- gasping with stretched neck and open beak
- wheezing and gurgling respiratory sounds, and severe respiratory distress
- coughing and sneezing
- conjunctivitis
- drop in egg production.

Up to half of the flock may die after severe respiratory distress.

Post-mortem findings

Bloody mucus and cheesy material may be found in the tracheae of diseased birds.

Control

There is no specific treatment for ILT. Vaccination is possible but not practicable under village conditions.

Chapter 9 provides general information on prevention and control of infectious diseases.

11.14 Marek's disease

Cause

Marek's disease (MD) is caused by a herpesvirus.

Transmission

The virus is shed with small parts of the feathers, fluff and dust. It can remain infectious for more than a year.

The disease spreads:

- by direct contact between birds (agents are inhaled by other birds)
- via the air
- by contact with contaminated feed or water
- on the shoes or clothes of people, or on equipment.

Species affected

Marek's disease affects domestic fowl including chickens, quail and pheasants. Young chicks are particularly susceptible to MD but resistance increases rapidly after the first few days of age.

Clinical signs

Clinical signs can be seen from 2 to more than 30 weeks after infection. They include:

- loss of feathers, nodules in the skin (in young birds from 4 weeks to 7 months of age)
- paralysis of one leg and/or wings (up to 7 months of age)
- loss of weight
- irregularly shaped pupils (in adult birds)
- lameness for a short period (in adult birds).

Mortality usually occurs between 10 and 20 weeks of age.

Post-mortem findings

Post-mortem indicators of MD are:

- tumours in internal organs such as the ovary, liver, spleen, kidney and heart (in young birds from 4 weeks to 7 months of age)
- thickened, greyish nerves, with loss of cross-striation (up to 7 months of age).

Control

Marek's disease cannot be cured. Vaccination of day-old chicks is possible but not practicable under village conditions. Selection for resistance to Marek's disease in chickens is possible.

Chapter 9 provides general information on prevention and control of infectious diseases.

11.15 Pullorum disease (bacillary white diarrhoea)

Cause

Pullorum disease is caused by a bacterium called *Salmonella pullorum*.

Transmission

The agent is shed in the droppings and can survive several months in the environment. It is destroyed quickly when exposed to direct sunlight.

The disease spreads:

- by direct contact between chicks (through the droppings)
- on the shoes or clothes of people, or on equipment
- from infected hens to their chicks via the egg
- via surviving chicks, which may carry the virus for life.

Species affected

Chickens, turkeys, quail and pheasant can be affected by pullorum disease. Only young chicks show clinical signs of the disease, from which they die in large numbers.

Clinical signs

Signs of pullorum disease are:

- chalk-white diarrhoea and a dirty vent
- weakness and closed eyes
- drooping wings.

Post-mortem findings

Post-mortem indicators of pullorum disease include:

- remnant egg yolk (persistent yolk sac) in the body cavity of young chicks
- small, whitish spots in the liver, heart and sometimes the lungs.

Control

Treatment with antibiotics is possible but the disease might reappear with the next group of chicks. It is therefore better to kill the infected mother hen to avoid further spread.

Chapter 9 provides general information on prevention and control of infectious diseases.

Public health

There are rare reports of enteritis in humans due to *Salmonella pullorum* infection. If an infected bird is eaten inadvertently, it is unlikely to cause a problem if the meat and/or eggs were well cooked.

11.16 Internal parasites (worms)

A variety of worms may be found in the digestive system of chickens:

- Large white roundworms (ascarids) (5–11 cm long) live in the intestines (Figure 40).
- Small, fine hairworms (*Capillaria* species) (1.5–8 mm long) can be found throughout the intestinal tract.
- Caecal worms (*Heterakis gallinarum*) (1–1.5 cm long) are located only in the paired caeca.

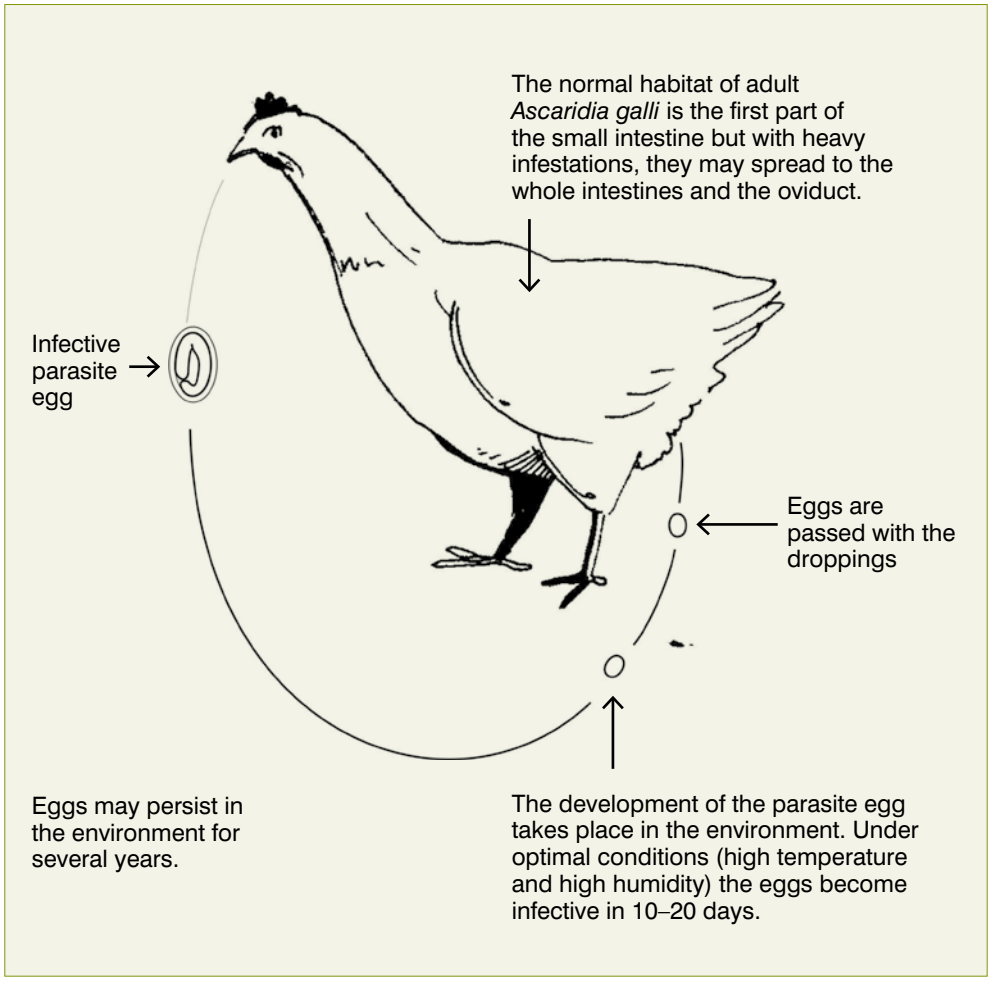

Figure 40. The life cycle of *Ascaridia galli* is direct; that is, the parasite passes directly from one bird to another via ingestion of parasite eggs. Occasionally, earthworms can act as transport hosts. After infection, it usually takes 40–60 days before the bird starts to pass parasite eggs in its droppings.

- Tapeworms, consisting of many small segments (proglottids) (7–10 mm long), live in the small intestine.
- Several types of roundworms of various sizes can be found in the crop, oesophagus, proventriculus or gizzard of chickens.

Other worms can be found in the trachea (Y-shaped, reddish gapeworms) or the eye of chickens.

Transmission

Worm eggs are shed in the faeces. Warm, damp conditions allow the worm eggs to survive in the environment for a long time.

Some types of worms (tapeworms, flukes, *Heterakis* and some *Capillaria* species) pass through an intermediate host such as an insect, earthworm or snail, which then might be picked up by scavenging chickens. The eggs of other worms (ascarids, some *Capillaria* species) are directly picked up by other chickens in contaminated feed or water.

Clinical signs

Worms cause damage to the gut wall and take nutrients from the chicken they are infesting. Infestations are of greatest importance in young birds, resulting in:

- loss of appetite and weight
- diarrhoea.

Worms or segments of tapeworms can be found in the faeces.

Control

Infestation with worms can be controlled using a suitable anthelmintic. However, the use of drugs for deworming without improving housing conditions as described in Chapter 4 will provide only a temporary improvement. Birds will be re-infested by the intake of worm eggs from their environment.

Reducing the numbers of worm eggs in the chickens' environment is crucial for the control of worms. This can be achieved by:

- cleaning the chicken house and removing droppings every week
- cleaning feed and water containers daily
- avoiding development of wet and muddy areas around water containers or elsewhere.

Traditional remedies such as pawpaw seeds may be used by farmers in some areas to control internal parasites.

12 Concluding remarks

Poultry have contributed to human health and wellbeing for thousands of years. Most people now live in urban areas and the commercial poultry industry has an important role to play in the provision of good-quality poultry and poultry products for these consumers. Nevertheless, village poultry continue to be an important part of livelihood strategies for millions of rural communities. Village poultry improvement programs developed in collaboration with producers and traders can improve not only the wellbeing of rural communities but also provide good-quality poultry to urban consumers who are willing to pay a price premium for birds raised under free-range, village conditions.

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Appendixes

The appendixes provide more detailed information on various topics relating to village chicken production.

Appendix 1

How to use this manual as part of a training course for livestock officers, extension agents, community animal health workers or farmers

The information contained in this manual can be used to assist participatory training and extension activities with livestock officers, extension agents, community animal health workers and poultry farmers. Participatory technology development and farmer field-school approaches are particularly suitable for the application and trial of information and techniques described here.

As noted in various sections of this manual, the constraints to local poultry production may include predation, inadequate nutrition, inefficient flock management and various diseases. The appendixes contain information that will assist with cost-efficient disease surveillance and the interpretation of serological results.

The participatory tools presented in Appendix 2 can be used to:

- identify and prioritise local constraints to village poultry production (community animal health worker and farmer-oriented training)
- identify and prioritise local constraints to disease surveillance, prevention and control (livestock officer and extension agent-oriented)
- identify available and affordable local resources to deal with the constraints
- plan trials to assess the usefulness of different prevention and control options under local conditions
- design participatory monitoring and evaluation activities to enable the definition of indicators and methods of verification by participants, implementers and donors.

Appendix 2

Participatory community exercises for identifying problems associated with village chicken production

Exercises

1. Awareness-raising activities and descriptions of the community and chicken production
   - (a) Wellbeing stratification exercise
   - (b) Community structures (Venn diagrams)
   - (c) Family roles related to chicken raising
   - (d) Ranking of activities according to their contribution to household income
   - (e) Chicken-raising calendar
2. Problem identification
   - (a) Ranking of problems related to chicken raising
   - (b) Focus group discussions
3. Dreams realised or visioning

Exercises 1(a) and 1(b) will help to identify the characteristics of social groups within a community and how various community structures interact. Exercises 1(c), (d) and (e) are related to identifying the importance of chicken production and the roles and activities associated with raising chickens. These last three exercises could also be used again later, to help evaluate and identify the changes that have occurred as a result of new chicken-management practices.

Exercises 2(a) and (b) can be used to identify problems associated with chicken production. They can also be used later, to help evaluate changes as a result of new chicken-management practices.

The third exercise may help the community to identify and envision potential benefits of improved village chicken production.

1(a) Wellbeing stratification exercise

Time required

Approximately 1 hour

Purpose

To identify three different socioeconomic groups in the target population, representative of the well off, the less well off and the poor. This information can

be used to identify households from each of the social groups. People from these different groups could be interviewed to determine the role that chickens play in their production system and to identify constraints to production within each of the groups. This process will help to ensure that extension activities are meeting the needs of a wide range of people within the community.

Materials

Flip chart and felt pen

Process

Organise a meeting of around 30–60 people of the village representative of the well off, the less well off and the poor, and men and women.

1. The facilitator introduces the team, the objective and the exercise.
2. The facilitator asks participants to describe the characteristics of three social groups in the community: well off, less well off and poor. The information is listed on the flip chart.
3. The discussion should flow from one issue to the other logically. The following guidelines list the types of questions that can be asked to guide the discussion.

   Availability of food

   Do all households eat the same number of meals? Are there times of the year when some families do not have enough food? How often do families eat meat?

   Agricultural and livestock practices and assets

   Do all households own land? Do all households cultivate their own land? Do some households rent land? Do all households own hand tools? What types of households own oxen, ox ploughs and ox carts? What types of households own tractors? How do different households cultivate land (hand tools, ox ploughing, tractor or hired labour)? What types of food crops do different households grow? What types of livestock do different households own? Do all households own livestock? Do all households use agricultural inputs such as veterinary medicines and chemicals (vaccines, antibiotics, fertilisers, insecticides, herbicides, fungicides etc.)?

   Household income

   What are the major sources of income? What types of crops are grown? What types of livestock are raised? How important are chickens as a source of income? What are other sources of on-farm income (e.g. beer brewing)? Are there sources of off-farm income (e.g. school teacher, working on other farms)? How important is on-farm and off-farm income in different households?

   Household assets

   What different types of houses are there? How many households have thatched roofs or tin roofs? How many households live in mud and wattle

houses, or houses made of mud bricks or concrete blocks? Do all houses have a latrine? Do all households use mosquito nets? What are the main items of furniture owned in different households? What are the main kitchen utensils used in each house?

Social characteristics

What different types of households are there? Are there, for example, households that are primarily female or without adult male members; households with only old people; households with sick and physically infirm people; households with only children; households with young families; extended polygamous households; extended monogamous households? How many households pay local fees and levies?

4. The facilitator should either interpret the ideas coming from the participants to describe the characteristics of each social group or, alternatively, the characteristics should first be listed randomly and the second step would be to organise these different characteristics into the categories of well off, less well off and poor in a second stage of discussion.
5. If the facilitator wishes to work with families in each of these categories it is a good idea not to name the groups as 'rich or well off' or 'poor' etc., as this can be embarrassing or demeaning for participants. It is better to identify a main characteristic of each group, such as the number of cattle owned or the area of land farmed and categorise families accordingly.

1(b) Describing community structures (Venn diagrams)

Time required

Approximately 1 hour

Purpose

To help the community and the facilitators understand the organisational structures that exist within the community and how they relate to each other. This may help to determine the best ways to work with the community and to avoid conflicts between existing groups.

Materials

Flip chart and pen; scissors; tape or glue

This activity can be carried out with village leaders and also with same-sex meetings of 20 men and 20 women of different social groups. The meetings can be held on different days.

Process

- Using a sheet of paper from a flip chart, ask the participants to list all of the groups and structures (formal and informal; official and unofficial) within their village.

- Using a new sheet of paper, draw a circle for each group/structure in the list and write the name of that group/structure in the circle. The more important the group, the larger should be the circle.
- Cut out each circle.
- Arrange the circles on a fresh sheet of paper to illustrate the overall system and to show relationships between the different parts. Circles can overlap, be far apart, close together, or within other circles etc.
- Display and explain the system developed to the other groups so that differences can be discussed. Analyse key differences between the groups and the underlying causes.

Notes

This can be a very illuminating exercise for the community, as certain aspects of their village life and organisation may be explicitly revealed for the first time. It will also show the different perceptions of different groups. It may help to highlight different roles, responsibilities and linkages, pointing to areas of conflict and dispute as well as to ways of resolving them.

Different groups may produce completely different diagrams. These can then be discussed to help resolve conflicts and encourage linkages. However, it may not be possible to pull all of these systems together into something that represents them all. Diversity needs to be accepted.

1(c) Identifying family roles relating to chicken raising

Time required

Approximately 1 hour

Purpose

- To understand the roles of different family members so that meetings and training can be conducted with the appropriate family member(s).

Materials

Flip chart and felt pen

Process

- Draw the following table (Table A1.1) on a flip chart and leave space at the bottom for adding extra tasks.
- Either in one large group or in groups divided into men and women, discuss the tasks listed in the table and ask participants to add or remove tasks according to what is normally done to look after village chickens.
- Ask participants to identify who performs the different activities related to chicken raising and to fill in the table.
- Discuss the main findings and assess who should be most involved in training or activities related to chicken raising to ensure that the person involved with the activity is adequately informed and is in charge of it.

Table A2.1 Family activities related to chicken raising

Activities	Adult men	Adult women	Boys	Girls	Older men	Older women
Large species of livestock						
Small species of livestock						
Chicken raising						
Who gives feed?						
Who gives water?						
Who built the chicken house?						
Who prepared the place for the hen to hatch?						
Who cleans the house?						
Who receives information on chicken raising?						
Who owns the birds?						
Who decides when to sell birds?						
Who decides when to sell eggs?						
Who decides whether to vaccinate?						
Who decides on need for and level of supplementary feed?						
Who opens and closes the chicken house door?						
Who collects the eggs?						
Who slaughters birds and prepares them for consumption?						
Who can eat birds?						
Who can eat eggs?						
Who decides when to eat birds or eggs?						
Who takes care of sick birds?						
Who decides if vaccination was successful?						

1(d) Ranking of activities according to their contribution to household income

Time required

Approximately 30 minutes

Purpose

- To identify how important chicken raising is in different households in comparison to other enterprises
- To understand the reasons for the relative importance of chicken raising
- To measure the change in importance attached to chicken raising as improved management techniques are introduced

Materials

Flip chart and pens; A4-size paper; drawings; stones or beans

Process

- Organise two meetings, one with 20 men, the other with 20 women, the participants in each case being drawn from a range of social groups. The meetings can be held on the same or different days.
- Each group should be divided into the three social categories (remembering not to ask people to divide according to categories such as 'rich' or 'poor', but rather according to less sensitive descriptions such as those who own many cattle, a few cattle or no cattle.
- Conduct one of the following two exercises with each group:

1. Simple ranking

(a) The facilitator introduces the team and explains that the objective is to identify the importance of chicken raising relative to other household activities. The facilitator explains that everybody should contribute with their ideas. (Register the total number of participants in the group.)

(b) Identify the major crops, animal enterprises and other activities in the participants' livelihood strategies.

(c) Either use existing drawings or draw the animals, crops and activities on cards.

(d) Distribute the same number of stones or beans to each of the participants. Ask each of the participants to put a number of stones on the drawing according to their importance in their household livelihood. Ask each participant to justify their ranking. (Verify that each participant uses all the stones distributed.)

(e) At the end of the exercise, count the stones on each of the activities. Calculate the contribution of each activity as a percentage of the total. (Divide the number of stones in each drawing by the total number of stones distributed and multiply by 100.)

(f) Discuss with the participants the result obtained. Verify that it corresponds to their perception of the reality. Discuss its implications for the project.

2. Preference ranking

Preference ranking is a variation of simple ranking and can be used as an alternative to it. It involves the participants assessing the relative importance of different farm enterprises using criteria they themselves identify. The ranking can be undertaken using a matrix with farm enterprises on the horizontal axis and the selected criteria on the vertical axis. An example is given in Table A2.2.

The advantage of preference ranking over simple ranking is that the participants select the criteria for ranking and so it is easier to understand the reasons for the ranking. The disadvantage is that it is more difficult to facilitate.

The following steps are involved in farm enterprise preference ranking:

(a) The facilitator introduces the team and explains that the objective is to identify the importance of chicken raising relative to other household activities. The facilitator explains that everybody should contribute their ideas. (Register the total number of participants in the group.)

(b) Ask participants to identify the six most common farm enterprises. Ensure that chicken raising is included in the list.

(c) Ask participants to select criteria for ranking the importance of each enterprise by asking the following questions: 'What is good about this enterprise?' 'What else?' (Continue until there are no more replies.) Then ask: 'What is bad about this enterprise?' 'What else?' (Continue until there are no more replies.)

(d) List all the criteria.

(e) Turn negative attributes into positive ones (e.g. 'prone to disease' becomes 'disease resistant'; 'a lot of work' becomes 'little work')

(f) Help participants to draw up a matrix with criteria listed down the side of the matrix and enterprises along the top. (Where possible, use symbols for the row and column titles—either prepared before or prepared at the meeting.)

(g) Using a five-point scoring system in which five points is the highest and best score, in a group exercise rank each of the enterprises for each of the criteria.

(h) When the exercise is completed, cross-check the ranking of each enterprise, by asking a question to confirm its ranking (e.g. 'It seems that chicken enterprises are/are not very important for household income. Is this correct?').

(i) Follow up the ranking results by a discussion to explore different viewpoints.

(j) This exercise will require two facilitators; one to assist the participants in the exercise and the other to record the discussions.

Table A2.2 gives an example of how a preference ranking matrix for the above exercise might look. (The values shown are examples only.)

Table A2.2 An example of a preference ranking matrix

	Chickens	Goats	Cashew	Maize	Beans	Cassava
Profitable	1	2	4	3	4	3
Disease free	1	1	1	3	3	4
Easy to sell	4	4	4	3	4	2
Low labour needs	5	4	3	2	2	3
Available when food for the family is in short supply	4	5	1	1	1	4
Total	15	16	13	12	14	16

This table indicates that cashew and maize may be less important than the other four activities.

1(e) Chicken-raising calendar

Time required

Approximately 2 hours

Purpose

To identify when the main activities relating to chicken raising occur throughout a year. To provide a structure to allow an exploration of important issues relating to chicken husbandry practices; chicken and egg consumption and marketing; knowledge of, attitudes to and responses to Newcastle disease (and/or other important poultry production constraints); and community ideas for improving any existing ND control activities. The data collected will complement the data collected in the baseline survey.

Frequency

To be undertaken in the initial participatory rural appraisal (PRA) and annually thereafter.

Materials

Flip chart and pens; drawings of different activities (the participants can also draw these); glue; notebook

Process

Two facilitators are required, one to lead the discussion, the other to take notes.

Organise meetings of same-sex residents, with around 20 people in each group. The meetings can be held one after the other or on different days.

1. A facilitator introduces the team and explains the objective of the exercise: to discuss chicken-raising activities.
2. When an activity occurs at a specific time of the year, it is put on the calendar. Other information is collected in a notebook.
3. Residents draw an annual calendar divided into 12 monthly columns on the flip chart. The facilitator should assist if required.
4. The discussion should flow logically from one issue to the other. Examples follow of the types of questions that can be asked to guide the discussion:

Chicken ownership

- Does everybody own or look after chickens? Who does not have any and why? How many chickens does each person own or look after? What is the normal (average) number of chickens owned or looked after by a household?
- In which months do people have more chickens? Why? Is it during harvest period? When do they have less? Is it at the end of the hungry period? (Mark on the calendar (see Table A1.3) the month when households have most chickens and when they have the least chickens.)
- Who owns the chickens in the household? Who takes care of them?

Chicken husbandry practices

- What do chickens eat?
- Where do chickens sleep at night? How secure is the chicken house?
- What are the main problems with chicken raising? Diseases, names of the diseases, explanation of the origin and transmission of the diseases, other problems? (Record the information about diseases in the notebook and mark the appropriate months on the calendar.)

Newcastle disease

- When do ND outbreaks usually occur? When are the peaks of the disease? (Record the information about ND in the notebook and mark the appropriate month(s) on the calendar.)
- How do you recognise ND (what are its characteristics)? What prevention and treatment methods do you use? Who gives the treatment? (Record the information about when treatment is normally given in the notebook and mark the appropriate month(s) on the calendar.)
- Repeat for other significant diseases in the area.

Agricultural calendar

- Which months are the rainy seasons? In which months are the main agricultural activities undertaken? (Record the information in the notebook and mark on the calendar the months in which the various activities normally occur.)

Consumption of chicken products

- When do people usually eat more chickens and eggs? Why? Is it during feasts or before a ND outbreak? (Record the information in the notebook and mark the relevant months on the calendar.)
- Who usually eats the different parts of the chicken? Why? Who eats most of the chicken? At what age can a child start eating eggs or chicken? Why? Do pregnant women eat eggs and chicken? Why or why not? (Record the information in the notebook.)

Chicken and egg sales

- What is the price of a chicken and of an egg in the different periods of the year? Are they (birds and eggs) sold by piece or by weight? When is the price lower and when is it higher? Why? (Record the information in the notebook and mark the relevant months on the calendar.)
- Where do people usually sell chickens and eggs? Why? Is the price the same in the different locations? (If there is a seasonal variation, record the information in the notebook and mark the relevant months on the calendar.)
- Who sells eggs and chickens (men, women, children)? What do they do with the money? Who controls the money from the sale of chickens? (Record the information in the notebook.)
- Who makes the decision to eat or sell? (If there is a seasonal variation, record the information in the notebook and mark the relevant months on the calendar.)

Newcastle disease vaccination

- Have you heard about ND vaccination? With what type of vaccine: La Sota, I-2, some other type? What is it? Who stores or looks after the vaccine? Who organises the vaccination? Is a campaign or ongoing vaccination approach used? Is ND vaccine available in the village? (If there are campaigns against ND, record the information in the notebook and mark the relevant months on the calendar.)
- How effective was the vaccination? Did all the chickens that were vaccinated survive the ND outbreak? Was there any difference in deaths from ND between vaccinated and non-vaccinated birds? How do you think the vaccination process can be improved? (If the timing of existing vaccinations should be altered, record the information in the notebook and mark the recommended time on the calendar.)

Table A2.3 **An example of a chicken-raising calendar summarising data gathered in 2003 before vaccination with Newcastle disease vaccine began in Mtwara region, Tanzania**

Issues	J	F	M	A	M	J	J	A	S	O	N	D
More chicken die of lice						x	x	x				
ND outbreak									x	x	x	x
Rain	x	x	x	x							x	x
Weeding		x	x									
Land preparation										x	x	
Harvest					x	x	x	x	x			
Few chickens	x	x	x					x	x	x	x	x
Hunger period	x	x	x	x					x	x	x	x
Many chickens						x	x	x				
More chickens are eaten								x	x	x	x	x
High price for chickens	x	x	x	x	x							
Low price for chickens							x	x	x	x	x	x

2(a) Ranking of problems related to chicken-raising

Time required

Approximately 30 minutes

Purpose

To rank the relative importance of the different problems facing chicken raisers over the life of the project.

Frequency

To be undertaken in these participatory community exercises and annually thereafter.

Materials

Flip chart and pen; drawings; stones or beans

Process

This activity can be carried out with separate meetings of up to 20 men and 20 women, participants in each case being drawn from the three different social groups. The meetings can be held on different days. The activity should be conducted annually.

1. The facilitator presents the team and explains that the objective of the exercise is to discuss the problems related to chicken raising and to rank them according to their importance. Everybody is asked to contribute their ideas. (Write down the total number of participants.)

2. Discuss what are the main problems with chicken raising.
3. Use existing drawings or ask the participants to draw the different activities.
4. Distribute the same number of stones or beans to each of the participants. Ask each of the participants to put a number of stones on the drawing according to their importance. Ask each participant to justify their ranking. (Verify that each participant uses all the stones distributed.)
5. At the end of the exercises, count the stones on each of the cards/ drawings. Calculate the percentage of stones placed on each card/ drawing by dividing the number of stones in each drawing with the total number of stones distributed and multiplying by 100 (Table A2.4). Convert the percentages to a ranking, with 1 being the highest ranking (highest percentage) and record the rankings on the flip chart (Table A2.4).
6. Discuss with the participants the results obtained. Verify if it corresponds to their perception of reality. Discuss its implications for the project.

Note: This exercise could also be undertaken using pair-wise ranking where each problem is compared in importance to every other problem.

Table A2.4 An example of problem ranking by men and women in 2003 and 2005 in Dodoma region, Tanzania. Vaccination against Newcastle disease began in 2003.

Issue	2003	2003	2005	2005
	Men	Women	Non vaccinating	Vaccinating
Newcastle disease	1	1	1	
Predation/theft	2	9		
Coughing	6	5		
Housing	5	2		4
External parasites	3	3		2
Fowl pox	8	4		
Diarrhoea	7	7		
Feed	8	7		
Marketing	3	–		
Swollen liver		6	3	
Swollen eyes/head			2	1
Death of chicks				3
Worms				4
Infectious coryza			4	

2(b) Focus group discussions

Time required

Approximately 1–2 hours

Introduction

Focus group discussions (FGDs) are one of the main tools to be used to collect data about the implementation and effectiveness of vaccination campaigns.

Focus group discussions are facilitated discussions held with small groups that have either homogeneous or heterogeneous views. Group size should be kept to between 8 and 12 persons. The discussions usually last 1–2 hours and have many potential uses, including:

- to serve as a forum for addressing a particular issue to highlight various concerns, conflicting interests and common ground among different groups
- to provide an opportunity to cross-check information collected using other techniques
- to obtain a variety of reactions to hypothetical, planned or actual interventions.

The skill of the facilitator is an important element in the success or failure of FGDs. The person who guides the focus group uses group-process skills to ensure that all the participants can speak openly and to direct the discussion to the relevant topic.

The most useful outputs of these discussions are in the form of qualitative insights and direct quotations illustrating the views of the group's members.

Focus group discussions will be used on the project to empower communities and to collect information for strategic planning and impact assessment.

The next sections outline the overall approach and tips for facilitators on how to prepare for and conduct FGDs.

Focus group discussions can also be used to collect information about gender, poverty alleviation, the extent of community participation and many other areas.

Purpose

Focus group discussions provide forums at which community members can discuss the performance, effectiveness and impact of vaccination campaigns, and make recommendations for improvements. The results of the discussions should be communicated to vaccinators, supervisors and national coordinators and other service-delivery agencies so that planning, implementation, monitoring and effectiveness can be improved.

Frequency and timing

Focus group discussions should be held at the end of every vaccination campaign in all pilot villages where vaccination campaigns are conducted.

Participants

Focus groups comprising between 8 and 12 people should be formed. A person trained by the project will facilitate each group. Two groups will be formed in every project village, one comprising men the other women. The groups should be representative of the three wealth categories in each village, and of vaccinating and non-vaccinating farmers.

Topics for discussion

The main topics of discussion will be: How effective was the last vaccination campaign? How can implementation be improved? What benefits have been created as a result of the vaccination campaigns? Who are the beneficiaries? The project will provide facilitators with general checklists of topics to be covered for each campaign; see example in the box below.

First Newcastle disease vaccination campaign, checklist of subtopics

- Timing of the vaccination campaign
- Methods used in the campaign
- How can campaigns be improved?
- Numbers of chickens vaccinated
- Numbers of farmers vaccinating chickens
- Reasons why some farmers vaccinated and others did not vaccinate
- Knowledge about vaccinations among group members
- Attitude to vaccinations among group members

Length of group discussions

Discussions should last 1–2 hours.

Recording of the discussions

The facilitator should keep a record of the discussion and they should leave a copy with the community. If possible, somebody should assist the facilitator to record the discussions.

Reporting of focus group discussions

The facilitator should report on the FGDs to district-level personnel who should, in turn, report to regional authorities.

Tips on how to prepare and conduct focus group discussions:

- Have a clear purpose for the group discussion, based on the general project checklist.

- Prepare a checklist of issues to be covered in the discussion, based on the general checklist prepared by the project. Prepare prompts that can be used to open up areas that need to be discussed.
- With the help of local leaders and key informants (including the vaccinator and supervisor), identify participants. Ensure all required subgroups are represented.
- Advise people well in advance when the discussions will be held.
- Ensure there is a comfortable and pleasant atmosphere. Arrange snacks and drinks.
- Start the discussion with enough authority to keep the discussion on track, but with sufficient sensitivity to include everybody in the discussions. It is a good tactic to say that you are not an expert on the issues that are being discussed and that you want the participants to help you understand the issues better.
- Try to identify which issues are of general concern to the group and which issues are more controversial or personal in nature.
- When important issues have been agreed by the group, ensure that you fully understand them. A good way to make sure you understand is to paraphrase what they have agreed and ask them if you have understood properly.
- Look for potential spokespersons from different focus groups who could be asked to meet together to summarise the concerns of their groups and discuss differences between the groups.
- The facilitator would identify prompts and questions for each of the subtopics to assist spokespersons to facilitate the discussion.

3 Dreams realised or visioning

Time required

Approximately 1 hour

Purpose

To identify how participating stakeholders expect the project will benefit them, and what other changes they expect from the project over a longer time scale; e.g. 10 years. To identify indicators and to discuss how to measure the benefits and changes expected.

Process

The following method could be used.

- In one large group, start by asking participants how they would like things to be as a result of improved chicken production in the future. Ask the participants to reflect individually on the following question: How would you describe *the ideal situation we wish to achieve here in 10 year's time as a result of improved chicken production*? (10 minutes)

- Divide into subgroups (by gender if appropriate) and write down on cards or create symbols for the visions. (15 minutes)
- Meet in the large group to discuss the visions, to identify how best the community can assess the progress being made in achieving the visions and to agree on how the community will keep track of the changes. (30 minutes)
- The development of the dreams/indicators needs to be properly recorded so that a time series of information is stored. It is important to compare the current dreams with those identified previously, to discuss why changes have occurred and to what extent changes have been caused by project activities or external factors.

Appendix 3

Collection of blood samples

The examination of serum can reveal previous contact of the sampled bird with a particular infectious agent (ND virus, for example) and provide information about the success of vaccination. It takes some time (generally about 2 weeks) after vaccination or contact with an infectious agent before antibodies to the agent are found in the blood.

Further information on serology is given in Section 5 of Appendix 5.

Blood samples can be collected from the wing vein of chickens. It is possible to pierce a wing vein with a needle and collect the freely flowing blood into a small container. This delivers a sample that will probably be contaminated with bacteria and is less satisfactory than a sample collected using a syringe and needle. Also, the chicken is likely to be discoloured with blood, and some owners will object to this. The technique described below is less likely to stain the chicken with its blood and yields a better-quality blood sample. It based on the technique used by Dr Janeen Samuel (Australia) and Dr Rini Dharsana (Indonesia).

Materials needed

This technique uses a needle and syringe, both of which can be washed for reuse, though the needle less often than the syringe:

- a 25 G (0.50 × 16 mm) needle is used for chicks under 4 weeks of age
- a 23 G (0.65 × 32 mm) needle for older chickens.

Plastic syringes of 1.0 or 2.5 mL capacity are convenient.

If you have an assistant:

1. Ask the assistant to hold the chicken horizontally against their body with its head to their right.
2. Pull the right wing out towards you, pluck away the small feathers from the underside of the wing overlying the humerus, if necessary, and swab with 70% alcohol. The wing vein, named in various textbooks as the brachial, ulnar or cutaneous ulnar vein, is clearly visible running between the biceps and triceps muscles.

If working alone:

1. Sit with the chicken held horizontally between your thighs, head away from you, lying half on its back and half turned on its right side. (Some people prefer to hold the bird with its head towards them.)
2. Clamp down its legs with your left elbow (if you are right-handed) and its neck with your left forearm, and with your left hand spread out its left wing.

3. Insert the needle under the tendon of the pronator muscle, in the triangle formed where the wing vein bifurcates (see Figure A3.1), pointing the needle in the direction of the blood flow. Do not insert the needle too deep or it will scrape the humerus and the chicken will struggle. Also, avoid the ulnar nerve. With a little gentle probing you should enter the vein easily. (This approach from under the tendon makes it easier to enter the vein than does aiming directly for it, and also tends to steady the needle if the bird moves.)
4. Use only gentle suction to withdraw blood since the veins on chickens collapse readily. Collect 1–2 mL blood per chicken.
5. After the needle is removed, apply pressure to the vein for a few seconds to discourage further bleeding. Immediately cap the needle to prevent needle-stick injuries.
6. Immediately label the syringe with the number of the chicken.
7. If the blood is for serum collection, leave it in the syringe and store the syringe in a slanting position, with the *capped* needle end pointing upwards. Leave an air space between the blood and the needle end of the syringe. If possible, leave the syringes in a warm room at 37 °C for 1 hour to assist coagulation.
8. Ensure that all sharp items (e.g. needles) and contaminated items are disposed of in a safe manner.

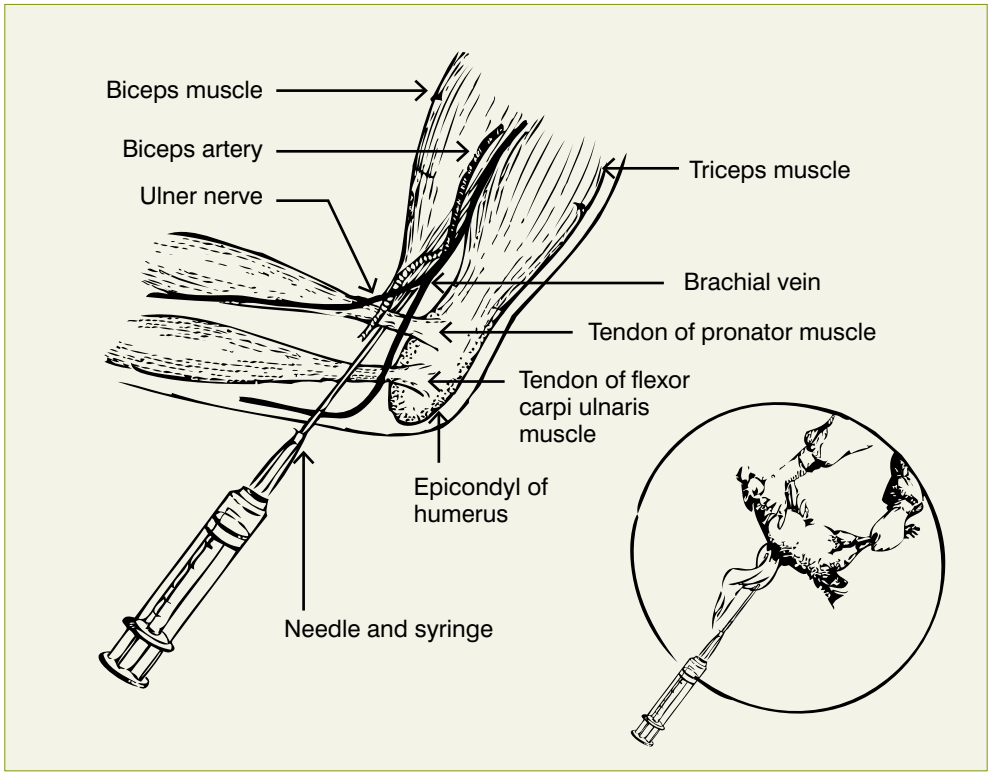

Figure A3.1 Illustration of a convenient anatomical site for bleeding chickens (adapted from J. Samuel, Virology Laboratory, University of Queensland)

Appendix 4

Post-mortem examination

A4.1 General information

When conducting a post-mortem, always wear appropriate protective clothing—gloves, waterproof apron, rubber boots and coveralls (overalls). If you suspect that the bird may have died of a zoonotic disease, a face mask (type N95) and goggles should be worn.

Clinical signs of sick chickens are often general (e.g. weakness, drooping wings, inappetence), or similar for several diseases (e.g. diarrhoea, respiratory distress). A post-mortem ('after death') examination reveals the organs affected by the disease and may also show characteristic lesions. Thus, post-mortem examination of a bird that died or has been killed after being sick strengthens and verifies a diagnosis based on case history and clinical examination. In this way, diagnosis of poultry diseases at field level can be enhanced with only limited financial input.

In general, post-mortem examinations are best performed in diagnostic laboratories. However, conditions in the field (long distances and lack of transport and cooling facilities) often make it impossible to send birds to the laboratory. Therefore, an extension officer should be able to confirm their diagnosis by performing a post-mortem in the field.

> **Note:**
>
> If there is a possibility that the bird to be examined has been infected with a zoonotic disease such as HPAI, it is essential that the technician use personal protective equipment (including gloves, a fitted N95 mask, safety goggles and coveralls).

Requirements for post-mortems performed under field conditions:

- **Materials needed**
  - a tray or a thick layer of clean paper (to perform the post-mortem on)
  - a sharp knife (to cut the muscles and skin). A stainless steel knife with a plastic handle is best. Ensure that it can be cleaned easily.
  - a pair of scissors (to cut muscles and skin and to open the intestines). Curved surgical (Mayo) scissors with both points rounded are best.
  - a pair of shears or garden secateurs (to cut the bones). A cheap, heavy pair of ordinary kitchen-type scissors is useful for cutting bones. If at least one blade is sharp-pointed, these scissors can be used for exposing the brain. For larger birds, ordinary garden pruning shears are ideal.

– a pair of forceps (rat-toothed are best; to hold any part of the carcass). If ordinary non-toothed forceps are used to handle organs and tissues, excessive handling and squeezing may damage the tissues. If fingers are used, the dissection field may become smeared with blood, which obscures detail. Fingers also tend to cause more bacterial contamination of exposed surfaces.

These materials should be washed and disinfected after each post-mortem. If disinfectant is not available, boiling water may be used instead.

If samples are to be sent to a laboratory for further diagnosis:

– bottles containing 50% glycerine in saline
– bottles containing 10% formalin *(The volume of 10% formalin used should be at least 10 times that of the tissue to be fixed.)*
– a cool box with ice or ice-packs (if possible).

Glycerine in saline is used to preserve samples for virus isolation. Formalin is used to preserve and fix samples for histological examination.

- **Where to perform the post-mortem**

  The post-mortem should be performed in dry, clean surroundings with as little dust and wind as possible.

  It should be performed on an even surface that:

  – is big enough to spread out the carcass and the organs (40 cm × 30 cm)
  – can be cleaned properly afterwards or will be discarded
  – does not allow the ground to be contaminated with any liquid (blood, faeces, intestinal content) or small parts from the carcass. (Sick chickens may carry and spread infectious agents.)

- **Selection of birds**

  When selecting birds for post-mortem, it is best to choose live birds that are showing typical signs, rather than dead birds or those that have been sick for some time. In dead or chronically ill birds, the primary disease may be obscured by secondary diseases or by post-mortem decomposition.

  If you are investigating a flock problem, then it is important to examine more than one sick bird at necropsy. For example, if three birds were examined, the accuracy of the subsequent diagnosis would be several times more likely to be accurate.

- **Disposal of the carcass**

  After doing a post-mortem the remaining carcass and all parts of the bird (including the feathers) should be buried or burnt to avoid further spread of infectious agents.

A4.2 Humane slaughter of birds

It is important to kill birds in a humane, efficient manner that does not itself cause changes that might confuse the diagnosis. Three techniques are described in this section. The first, cervical dislocation, is the most practicable under village conditions. Note that each of the techniques prevents the contamination of the environment with blood during the slaughtering process.

Examine the bird for clinical abnormalities before it is killed. This may indicate a particular system or organ that needs special attention during the post-mortem examination.

Cervical dislocation

1. Grasp the legs and primary wing feathers with one hand, so the bird cannot flutter.
2. With the other hand, grasp the bird's head from above, holding the head between the first (index) and second fingers. Curve the fingers along the bottom of the jaw. This avoids pressure on the larynx and tongue when the neck is broken.
3. Hold the bird across your body, with its head downwards. No undue force is used at any time up to this point. Bend the bird's head backwards.
4. Break the bird's neck using a fairly strong, rapid stretching action, keeping the head bent backwards. The bird will lose consciousness immediately, but will make strong reflex movements for about 2 minutes after neck dislocation. While struggling continues, keep the bird immobilised by maintaining your grip on the wing bases. Elevate the head to lessen the likelihood of inhalation of crop content, which may be regurgitated.

Intravenous injection of air

1. Grasp the bird by the wing bases with the left hand and immobilise it over the edge of a table.
2. Pluck a few feathers over the brachial vein.
3. Compress the base of the wing with the left index finger to distend the brachial vein.
4. Place the needle into the vein and rapidly inject 6–7 mL of air. Reflex struggling is brief and there is no trauma to neck structures. The bird does not regurgitate, as it may after cervical dislocation. Again, the wing bases should be held firmly until struggling stops.

Burdizzo

The burdizzo, a pinching tool used in the castration of cattle, can also be used to break the necks of poultry.

1. Two people must work together to use this technique.
2. One person holds the bird by the legs and primary wing feathers.
3. The second person places the burdizzo over the neck of the bird and closes them quickly to crush the vertebrae.

A4.3 Post-mortem technique for domestic fowl

There are many protocols for doing a necropsy on a bird. One protocol is described here. Whatever protocol you choose to follow, it should be one that is thorough and systematic, and that you feel comfortable with.

Work safely and cleanly

Ensure that water and soap are available for hand washing.

Collect cloacal and tracheal swabs before you begin the necropsy.

To avoid unnecessary contamination, collect samples for laboratory diagnosis DURING the post-mortem, not afterwards.

Examination procedure

A good necropsy involves careful external and internal examination of the carcass.

1. Examine the whole body, vent, breast muscle, skin, feathers, comb and wattles, nostrils, eyes and beak.
2. Spray or dip the carcass in a dilute solution of detergent or disinfectant to wet the feathers and reduce the risk of aerosolising infectious particles.
3. Position the carcass on its back with the legs towards you. Strip the skin from the breast, neck and legs and dislocate the hip joints by bending both legs outwards so that the carcass lies flat.
4. Open the abdomen and chest cavity. Avoid damaging any structures inside the carcass.
5. Examine the position and general appearance of the organs.

This is the '**display stage**' of the necropsy and is critically important. It is the last time you will be able to observe the organs in situ in an undisturbed, uncontaminated state. Any abnormal proportions, positions and configurations of organs must be noted at this time. Any accumulations of fluid or fibrin are noted now, as is the overall state of nutrition, presence or absence of overall carcass discolouration etc. Most of these features will be lost or hidden once the necropsy proceeds.

6. Examine the **air sacs, heart** and pericardial sac. Remove the heart and cut it open.
7. Pull the proventriculus, gizzard and small intestine to your left. Examine the **abdominal cavity**.
8. Cut the oesophagus at the junction with the proventriculus and free the gizzard and liver from their attachments. Cut the colon just before it enters the cloaca. Gently lift the intestines and cut their connection to the gastrointestinal tract close to the gut. Take the whole bowel (proventriculus, gizzard and intestines with liver and spleen) out to the left.

9. Cut the spleen from the bowel and inspect the **spleen**.
10. Cut the **liver** from the bowel. Inspect the liver and note the size of the **gall bladder**.
11. Examine the **testes** in roosters, and the ovary, oviduct and uterus in hens.
12. Loosen the **lungs** from the ribs and roof of the thorax and examine them.
13. Remove the ovary and remains of the air sacs to reveal the **kidneys**. Note their size, shape and colour. Check the small tubes connecting the kidneys with the cloaca (**ureters**).
14. Examine the **nerves**—the sciatic nerve plexus, the sciatic nerve, the intercostal nerves (between the ribs), the brachial plexus and the spinal and vagus nerves in the neck.
15. In young birds, open the **bursa of Fabricius** through its opening to the cloaca and examine.
16. Examine the **leg joints** and open them.
17. Cut off the tip of the beak just above the nostrils with shears to open the **nasal cavities** and **sinuses**. Open and examine them for changes.
18. Open the beak, larynx and **trachea**. Spread the trachea and examine it for liquid or other content and changes in colour.
19. Starting at the **oesophagus**, open the entire intestinal tract (**crop**, **gizzard**, **proventriculus**, **intestine** including the **caecum**).
20. Remove the head and gently open the **cranium**.

Finishing up

Carcass disposal

Dispose of the carcass immediately after finishing the necropsy. Proper carcass disposal will prevent the spread of the disease agent to other animals or humans through environmental contamination.

Guidelines for effective carcass disposal are given in Chapter 9.

Cleaning up

All objects that have come in contact with potentially infectious materials should be cleaned and decontaminated immediately after the necropsy. This will prevent the spread of the disease agent to other animals or humans.

Sterilise instruments between each necropsy by immersing them in alcohol and flaming them, or by leaving them in an acceptable disinfectant for the prescribed time prior to thorough rinsing in sterile water.

Particular attention must be paid to reusable equipment, instruments, vehicles, the environment and your hands.

Ensure that you have water, a wash bucket, nail brush, soap, paper towels and spray disinfectant with you.

Samples

All samples should be marked with the date and a unique identification number. Use only one identification number per animal, even if you are collecting several samples from the animal.

Data recording

Complete a detailed necropsy report to document your observations. Also complete a sample submission form and list the samples that you have collected.

A4.4 Common post-mortem lesions in chickens

Table A4.1 provides basic information on post-mortem lesions and their possible cause. The list is not complete and aims to help persons with little experience perform post-mortems on chickens.

Table A4.1 Signs that can be found doing a post-mortem on a chicken (listed in order of examination during the post-mortem examination)

Affected part of the body	Lesion	Possible cause
Muscles	Small haemorrhages (blood spots)	Infectious bursal disease (IBD)/Gumboro disease or septicaemia
	– pale	Infestation with blood-sucking parasites Loss of blood due to injury Rupture of the liver (fatty liver degeneration) Metabolic disorder
	– dark	Death after high fever
Air sacs	Cloudy	Chronic respiratory disease (CRD), infectious bronchitis (IB), colisepticaemia
	Pale mucoid thickened	Any chronic respiratory disease
Heart	Covered by cheesy material	Fowl cholera, fowl typhoid, colisepticaemia
	Covered with chalk-like material	Gout
	Fluid in the sac covering the heart	Fowl cholera, any disease affecting the circulatory system, nephritis
	Yellowish colour	Metabolic disorder, intoxication
	Small haemorrhages	Newcastle disease (ND), fowl cholera, highly pathogenic avian influenza (HPAI), other acute viral or bacterial infections
	Small white spots	Fowl typhoid, pullorum disease, Marek's disease, coligranuloma, tuberculosis
	Froth in the right atrium	The bird was killed by an intravenous injection of air.

Table A4.1 (Continued)

Affected part of the body	Lesion	Possible cause
Abdominal cavity	Cheesy content	Fowl cholera, colisepticaemia, fowl typhoid
	Liquid content	Fowl cholera, any heart or liver disease, intoxication
	Persistent yolk sac	Pullorum disease
	Tumours in or on various organs	Marek's disease, leucosis, various tumours
Spleen	Pale	Fowl typhoid
	Swelling	Fowl typhoid, fowl cholera, Marek's disease, leucosis
	Small haemorrhages	Fowl typhoid
	Small white spots	Tuberculosis, coligranuloma
Liver	Swelling	Fowl typhoid, fowl cholera, Marek's disease, leucosis, colisepticaemia
	Covered with cheesy material	Fowl cholera, fowl typhoid, infection with *Escherichia coli*
	Covered with chalk-like material	Gout
	Small white spots	Fowl typhoid, pullorum disease, Marek's disease, leucosis, coligranuloma, tuberculosis
	Pale yellow colour	Fatty liver degeneration
	Small haemorrhages	Fowl cholera, fowl typhoid
	Round lesions surrounded by haemorrhages	Histomoniasis (parasitic disease)
Ovary	Bloody	Acute infection, intoxication, ND
	Semi-solid ova	Bacterial infection
	Misshapen, discoloured ova	The hen has recently stopped laying eggs. Fowl typhoid, tumours, Marek's disease
Oviduct	Enlarged with cheesy content	Inflammation after bacterial infection
Lungs	Small white spots	Fowl typhoid, pullorum disease
	Small haemorrhages	Fowl cholera
	Cheesy content	CRD
	Foamy content	IB
Kidneys	Pale	Fowl typhoid, fatty liver degeneration, IB
	Swelling	Fowl typhoid
	Small haemorrhages	Fowl typhoid
Nerves	Thickened, greyish	Marek's disease

Table A4.1 (Continued)

Affected part of the body	Lesion	Possible cause
Bursa of Fabricius	Abnormal in size (enlarged or too small)	IBD
	Small haemorrhages	ND, IBD/Gumboro
	Cheesy content	IBD/Gumboro
	Small tumours	Leucosis
Trachea	Small haemorrhages	ND, laryngotracheitis, gapeworms
	Red worms	Gapeworms
	Yellow–white lesions	Fowl pox
	Mucous content	ND, IB
	Cheesy content	Infectious laryngotracheitis (ILT), IB
	Bloody content	ILT
Oesophagus	Yellow–white lesions	Fowl pox
Proventriculus	Small haemorrhages	ND, HPAI, intoxication, gout
	Blisters	Infestation with flukes
Small intestine	Ballooning	Coccidiosis, bacterial infection
Large intestine	Nodules	Tuberculosis, cancer of the pancreas
	Small haemorrhages	Coccidiosis, fowl typhoid, fowl cholera, necrotic enteritis (bacterial disease), ND
	Small stripes or spots	Coccidiosis
	Foamy content	Coccidiosis, fowl typhoid
	Mucous content	Tapeworms
	Cheesy content	Coccidiosis
	Worms	Tapeworms, roundworms, hairworms
Caecum	Bloody content	Coccidiosis
	Cheesy content	Chronic coccidiosis, histomoniasis (parasitic disease)

Note: Further information on selected diseases is given in Chapter 11.

Appendix 5

Collection of samples for laboratory examination

A5.1 General information

To identify or confirm the cause of a disease, examination of selected organs or tissues in the laboratory may be necessary. A confirmed diagnosis is especially important if ND or HPAI is suspected, since these are devastating and therefore notifiable diseases.

The diagnosis of an infectious disease can be confirmed by isolating the causative agent from affected organs and identifying it. Further laboratory examination may also be required to confirm diagnoses of diseases or conditions related to poor husbandry or nutrition, or to identify inherited conditions.

For best results, samples should be examined as soon as possible after collection. There are two options: sick chickens could be sent to the laboratory (NOT advisable if an outbreak of ND or HPAI is suspected because other flocks could be infected along the way) or samples could be collected at post-mortem in the field and conserved before submission to the laboratory.

When taking samples during a post-mortem:

- collect samples from sick chickens (or when no sick chickens are available, from birds that died recently)
- make sure that the instruments used to perform the post-mortem are disinfected, or at least cleaned with hot water
- make sure that the organs chosen for laboratory examination are not contaminated with dust or dirt during the post-mortem; handle organs using forceps
- submit several samples if possible, because this allows a wider range of examinations
- label all samples clearly.

Further details about the selection of samples for laboratory diagnosis of ND are given below. Information on selection of samples for other diseases is given in Section A5.5. Information on transport of samples and information that should accompany the samples is shown in Section A5.4.

A5.2 Samples for laboratory diagnosis of Newcastle disease

Samples should be collected from cases of suspected ND for virus isolation and identification. Fresh or conserved samples are suitable.

If samples will reach the laboratory within 24 hours, the **entire head** and samples of **spleen** and **lung** should be put in separate small plastic bags or leak-proof containers and kept cool.

If samples may not reach the laboratory within 24 hours, the **entire head**, the **long bones**, and samples of **spleen** and **lung** should be **conserved in 50% glycerine in saline**. These samples must also be kept cool.

A5.3 Samples for diagnosis of highly pathogenic avian influenza

Rapid test for influenza A

If HPAI is suspected, a rapid test for the detection of influenza A virus can be used by trained operators. Rapid on-site tests based on chromatographic immunoassay using rapid immuno-migration technology have performed best under field conditions.

A positive result with a chromatographic immunoassay test is usually a clear indication that the bird is infected with an influenza A virus. A false negative result may occur in approximately one in five cases truly positive for influenza A (false positives can be expected in up to 5% of uninfected chickens tested). Therefore, it is possible that the test will not detect up to approximately 35% of infected chickens. The test performs best (at the upper end of the ranges stated) when used to confirm a clinical suspicion of HPAI in live chickens that are severely ill or in birds that are not long dead, and it is for this purpose alone that it should be used. It does not perform well with birds that are incubating an infection.

When the test result is positive, the national HPAI contingency plan should be implemented immediately. When the test result is negative, samples should still be dispatched for laboratory testing, the area quarantined, and carcasses and contaminated material buried until the laboratory results are available.

Samples for virus isolation must always be collected

The use of the rapid test is NOT a substitute for the collection of specimens for virus isolation. Where HPAI is suspected, laboratory specimens must always be submitted for confirmation of the diagnosis and typing of the virus involved.

It is important that this kit be stored at 2–30 °C. It is best kept in the refrigerator (i.e. at 2–8 °C). DO NOT FREEZE the kit. It must not be stored in direct sunlight. If correctly stored, the kit can be used until the expiry date marked on the package label.

Tissue samples and swabs

Specimens should be collected from at least six birds. Preferably, three should be birds showing signs of the acute disease and the other three may be recently dead. The sick birds should be humanely slaughtered by cervical dislocation by hand or using a burdizzo.

If swabs are available, tracheal or oro-pharyngeal[3] swabs should be collected and placed in virus transport media.

If swabs are not available then the following tissues should be collected, placed in a sealed plastic bag and stored at 4 °C: spleen, lungs, air sacs, trachea, heart, pancreas, liver and kidneys.

If contamination is a problem, or storage conditions not ideal, then the whole head and a long bone should be placed in a sealed plastic bag and placed on ice.

These specimens should be transported in a secure container to the relevant veterinary laboratory. If specialised transport containers are not available, then a used, clean paint tin can be used. The plastic bag holding the specimens should be placed inside the tin and the tin placed inside a cool box containing pre-frozen ice packs.

Before reaching the international reference laboratory, the specimens should be stored and transported at 4 °C. The specimens must reach the laboratory as quickly as possible, as the virus may be inactivated after 4–7 days.

The specimens should NOT be frozen at –20 °C (i.e. the normal temperature in domestic freezers is –10 to –20 °C and so they are NOT suitable for storing samples destined for virus isolation). Repeated freezing and thawing must be avoided to prevent loss of infectivity. In the laboratory, the specimens will be frozen at –80 °C.

Transporting the virus on dry ice (i.e. frozen carbon dioxide) is not recommended as: (1) the dry ice may evaporate during the journey causing the specimen to thaw; (2) according to the International Air Travel Association regulations that cover the transport of goods on planes, dry ice cannot be placed in airtight containers; and (3) carbon dioxide can rapidly inactivate influenza viruses if it gains access to the specimens through shrinkage of tubes during freezing.

Serology

Blood samples should be collected for serum if there are suspicions of HPAI having occurred in the recent past, selecting in particular any birds that are known to have recovered from a respiratory disease. At the start

3 Tracheal swabs can be collected from dead birds. In live birds, it is more likely that samples will be collected from the oro-pharyngeal region (i.e. the throat area) as the birds will struggle to prevent the entry of the swab into the trachea.

of an outbreak, given the rapidity of spread of the disease in flocks, antibodies will rarely be present. The high fatality rate also leaves little opportunity for the virus to leave an antibody 'footprint' in the flock. Thus, serological tests do not assist greatly in the confirmation of HPAI A (H5N1) infections in chickens but can provide useful information in the case of ducks and geese.

Serological investigation in flocks vaccinated with homologous inactivated vaccines (i.e. H5N1, the same strain that is responsible for the outbreak) can be used to confirm that vaccination has stimulated an adequate immune response but not to test for the presence of disease. The use of heterologous vaccine (e.g. H5N2) will also affect serological investigations when the tests available can determine only the H subtype and not the N type of the virus.

Serum samples should also be collected from pigs, especially if they are showing signs of respiratory disease.

Sera should be separated from the clot as soon as possible in a clean area, taking care to transfer the reference details of each sample to the new tube. Sera may be stored at 4 °C for approximately 1 week, but thereafter should be frozen at –20 °C.

Good records and correct documentation are essential

When collecting samples, always record the sample number and case details (such as the village name, global positioning system (GPS) coordinates, species, history etc.). This will make follow-up communication with farmers and further investigations much easier.

A5.4 Sending samples to the laboratory

Organs will decompose at ambient temperature and infectious agents they contain may be destroyed. It is therefore very important that samples be kept cool until they reach the diagnostic laboratory. Pack samples in a cool box with sufficient ice or freezer bricks to keep them cold until they arrive at the laboratory. (Only samples conserved in 10% formalin for histological examination may be stored at ambient temperature.)

All specimens should be packed to prevent leakage, risk of accidental exposure of personnel handling the container, contamination of the sample or damage with water.

The cool box containing the samples should be clearly identified and accompanied by the following information:

- the name and address of the person sending the samples
- the date and location of sample collection

- case details—age, sex, breed, vaccination and treatment history, clinical signs, mortality and description of the outbreak
- differential diagnosis.

Central laboratories will usually have submission forms to record this information. It is advisable to have copies of submission forms available in field offices.

A simple and inexpensive container for the transport of hazardous biological specimens is described by Blacksell et al. (2006).

A5.5 Specific collection details

A5.5.1 Samples for diagnosis of viral diseases

Which samples can be used?

Virus isolation can be attempted from affected organs, which should be sent whole. Tissues, faeces and samples taken from any body fluid or moist surface using a sterile cotton swab can also be used for virus isolation.

Collecting the samples

Specimens should be collected by aseptic techniques, using sterile instruments and sterile containers. If this is not possible, try to work as cleanly as possible using instruments and containers that have been boiled shortly before use. Contamination of the specimen from other organs and tissues, and the environment (e.g. dust, dirt, feathers) must be avoided.

How to store the samples

- **Swabs**
  Swabs should be transferred to a transport medium immediately after collection. Suitable media should preferably be obtained in advance from the laboratory to which the samples are to be submitted. Swabs contain fresh samples and must therefore be sent to the laboratory immediately.
- **Fresh samples**
  Organs should be wrapped in plastic or placed in small bottles. Wrap or pack each organ separately. All fresh samples (organs, tissues, faeces and swabs) must be placed in a cool box with ice or icepacks soon after collection and submitted to the laboratory immediately.
- **Conserved samples**
  Where it is not possible to keep the samples cold, or when it is not certain that samples will arrive at the laboratory within 24 hours, organs or tissues can be conserved in 50% glycerine (glycerol) in saline and should be kept as cold as possible during dispatch. In the laboratory, the samples will be processed to isolate the suspected virus.

A5.5.2 Samples for diagnosis of diseases caused by bacteria or mycoplasmas

Which samples can be used?

Bacteria can be isolated from affected organs or fluids inside body cavities. Whole affected organs and samples of fluids or from moist surfaces, taken using sterile cotton swabs, should be sent to the laboratory. The swab is dipped into the fluid or stroked on the surface and then placed in a suitable transport medium.

For diagnosis of enteric bacterial diseases, intestinal contents, rectal swabs and smears of intestinal mucosa and pathological lesions can be used. To take a smear, firmly press a clean glass microscope slide onto the suspect area.

Collecting the samples

Specimens should be collected by aseptic techniques, using sterile instruments and containers. If this is not possible, try to work as cleanly as possible using instruments and containers that have been boiled shortly before use. Contamination of the specimen from other organs and tissues, and the environment (e.g. dust, dirt, feathers), must be avoided.

If fresh organs are being submitted for bacteriological examination, at the time of collection a small block of the organ should be fixed in 10% formalin for histopathology.

How to store the samples

- **Swabs**
  Swabs should be transferred to a suitable transport medium immediately after collection. Suitable media should preferably be obtained in advance from the laboratory to which the samples are to be submitted. Swabs contain fresh samples and must therefore be sent to the laboratory immediately.
- **Fresh samples**
  Organs should be wrapped in plastic or placed in small bottles. Wrap or pack each organ separately. Organs, and tubes containing transport medium with swabs, must be placed into a cool box with sufficient ice or icepacks to keep the samples cool until arrival at the laboratory. Samples must be submitted to the laboratory immediately.
- **Conserved samples**
  In general, all samples for bacteriological examination, except smears, should be kept chilled but not frozen, from the time of collection until they have arrived at the laboratory. Isolation of bacteria is not possible from conserved samples.
- **Smears**
  Smears are air-dried and wrapped separately for transportation.

A5.5.3 Samples for diagnosis of fungal diseases

Which samples can be used?

Any organs showing lesions can be submitted.

Collecting the samples

Specimens should be collected by aseptic techniques, using sterile instruments and containers. If this is not possible, try to work as cleanly as possible using instruments and containers that have been boiled shortly before use. Contamination of the specimen from other organs and tissues, and the environment (e.g. dust, dirt, feathers), must be avoided.

Small sections of affected organs should be conserved in 10% formalin for histopathological examination.

How to store the samples

Fresh organs for diagnosis of fungal diseases must be stored and transported chilled.

A5.5.4 Samples for diagnosis of parasitic diseases

Which samples can be used?

- **External parasites**
  Single external parasites (if it is possible to catch them) or infected feathers can be collected from the bird or their nests or roosts for identification.

  Scaly leg mites may be isolated by scraping the skin and scales of the birds' legs. (Since the lesions are characteristic for this parasite, laboratory confirmation of the diagnosis is rarely necessary.)
- **Worms**
  Worm eggs can be found in faecal samples. Fresh droppings from several birds can be collected and pooled (put together).

  Adult worms found in the intestines can be submitted to a laboratory for identification.

  Intestinal contents can also be submitted if infestation with worms is suspected.
- **Coccidia**
  Coccidia oocysts can be found in faecal samples. Fresh droppings from several birds can be collected and pooled (put together).

  Coccidia can also be found in smears or soft scrapings of intestinal mucosa. The mucosa of several sections of the small intestine and the caecum should be scraped with cover slips that are then put on slides.

Collecting the samples

If faecal samples are to be examined it is best to collect fresh droppings from several birds.

For isolation of scaly leg mites, scrape lesions on the chickens' legs using a knife moistened with paraffin.

How to store the samples

- **External parasites, adult worms**
  External parasites and adult worms can be collected in small leak-proof vessels and preserved in 10–15% KOH (potassium hydroxide) or 70% alcohol. External parasites found on the skin and feathers can be stored for some time before examination without conservation. Scrapings for examination of scaly leg mites can be submitted unpreserved in a small container.
- **Faecal samples, intestinal content**
  Faecal samples and intestinal content should be kept cool until they reach the laboratory.
- **Smears**
  Smears of intestinal content or mucosa should be kept cool until they reach the laboratory.

A5.5.5 Samples for histopathological examination

Histopathological examination of affected organs provides more information about the chicken's reaction to agents that cause disease, and may assist in identification of the cause of a disease.

Which samples can be used?

For histological examination, affected organs and tissues can be used.

Collecting the samples

Tissues collected at the port-mortem examination should be preserved immediately on collection (Table A5.1). Decomposed or frozen samples are unsuitable for histopathological examination.

It is important that only the edges of samples are handled so that histological detail is not lost.

- **Organs**
  Large organs or blocks do not fix adequately and are unsuitable for examination. In general, organs greater than 1 cm in thickness should be cut into 1 cm sections. Organs that are less than 1 cm thick can be fixed whole.
- **Nerves**
  Nerves commonly curl and twist when placed in fixative. Lay the nerve flat on a piece of card or stiff paper (which can be labelled) and allow to adhere for 3–5 minutes. The card with the attached nerve should then be immersed in fixative.
- **Oesophagus, intestines and other tissues**
  The section taken from any of these should include part of the lesion and the junction of the diseased portion with the apparently healthy tissue. To ensure adequate fixation, sections of unopened oesophagus or intestine should be immersed in fixative and gently pulled through the fixative a number of times to ensure that fixative enters the lumen.

How to store the samples

Samples should be fixed in 10% formalin. Always ensure that the tissue is preserved in an adequate volume of formalin: the volume of 10% formalin used should be at least 10 times that of the tissue to be fixed.

Samples fixed in 10% formalin can be stored for some time before examination, even at ambient temperatures.

Table A5.1 Organs or other specimens suitable for laboratory diagnosis of certain diseases or syndromes

Disease/syndrome	Specimen required
Chronic respiratory disease	Trachea, choanal (palatine) cleft
Coccidiosis	Faecal samples, intestinal content Swabs or soft scrapings from intestinal mucosa Portions of intestines showing lesions in formalin (for histopathology)
Colisepticaemia	Whole, fresh dead chicks Liver, kidney, lung Swab samples from the pericardial sac, air sacs and joints
External parasites	Parasites, infested feathers Scraped lesions of scaly legs
Fowl cholera	Liver, bone marrow *(recommended when specimens are not fresh or when contamination of tissues is likely)*, heart blood
Fowl plague, avian influenza	Cloacal and tracheal swabs Trachea, lungs, air sacs, exudate from the sinus
Fowl pox	Recently developed nodular lesions
Fowl typhoid	Liver, spleen, heart, ovary
Infectious bursal disease/ Gumboro disease	Bursa of Fabricius
Infectious bronchitis	Tracheal swabs, cloacal swabs Lungs, kidneys, oviduct, caecal tonsils *(Virus might be isolated from cloacal swabs or caecal tonsils even several weeks after clinical signs have disappeared.)*
Infectious coryza	Entire head Swabs from the sinus cavities *(Tracheal swabs do not always contain the causative bacterium.)*
Infectious laryngotracheitis	Tracheal swabs Trachea, lung
Marek's disease	Organs with tumours Nerves (for histopathology)
Newcastle disease	Spleen, lung, entire head, long bones
Pullorum disease	Whole, fresh dead chicks
Worms	Faecal samples, intestinal content

A5.6 Serology

Serological examinations provide valuable diagnostic information in poultry flocks. A variety of methods can be used to detect antibodies and antigens circulating in the chickens' blood for direct or indirect diagnosis of infectious agents.

This appendix does not provide information on techniques used for serological examination. It aims to assist with the interpretation of results.

Accurate interpretation of serological findings requires knowledge of the efficiency and reliability of the technique used (sensitivity and specificity), and information on the course of the disease and the impact of immune reactions caused by specific infectious diseases. High antibody titres do not necessarily indicate protection against a certain infectious disease: **Protection against infectious diseases is obtained by a complex cooperation of various components of a bird's immune system, antibodies found in the serum being only one of them**.

Optimal time for sampling

A serological reaction to any infection can be detected not earlier than 1 week after infection or vaccination. In general, blood samples are taken 2 weeks after vaccination when high antibody titres are expected.

Sampling size and selected birds

For an infectious agent that spreads quickly within a flock—like the ND or HPAI viruses—many positive results can be expected, while only a few positive results might be found for a slowly spreading infectious agent. Thus, the number of samples to be taken within a flock depends on the percentage of expected positive results and on the reliability aimed for the results.

In order to measure whether vaccination has been effective, birds could be sampled at a rate sufficient to determine whether 80% of birds had a protective titre, with an accuracy of ±10%. (Epidemiological theory suggests that if at least 70% of a population is immune then disease outbreaks are unlikely to occur because there are not enough susceptibles to propagate an epidemic. Determination of 80 ±10% allows an assessment to be made of whether or not more than 70% of the population have protective titres.) Table A5.2 lists the number of birds would then need to be sampled (sample sizes have been rounded up) according to flock size.

Table A5.2 Recommended number of birds to be sampled to determine if 80% of a flock has a protective titre after vaccination

Flock size	Sample size
100	40
200	60
300	55
400	55
500	60

When selecting birds for sampling, birds of all age groups should be included, not just chickens that are easy to catch. True random selection (giving every bird the chance to be sampled) provides more comprehensive information on the whole flock.

Positive results

Clearly positive serological results, even of single birds within a flock, indicate contact with the infectious agent—but not necessarily clinical disease caused by this agent (e.g. antibodies for IBD/Gumboro might be found in adult chickens, which do not get sick from this disease because IBD/Gumboro affects only young chickens). Furthermore, positive results do not reveal whether the infection occurred in the past or is still active. To get further information on the actual presence of an infectious agent, two samples taken within a certain time from the same bird have to be examined (see paired serum samples, below).

Negative results

Clearly negative results obtained from random samples, on the other hand, do not prove the absence of a particular infectious agent from the flock.

Paired serum samples

Examination of two samples per chicken with a certain time interval between the two samplings is known as examination of 'paired serum samples'. This method is used to get information on the time of infection. The time between the two samplings (2 weeks; Table A5.3) should be sufficient for antibody titre to develop.

Table A5.3 Interpretation of paired serological samples

Results		Interpretation
1st sampling	2nd sampling	
Negative	Positive	• A change from a negative to a positive result (antibody status) is known as seroconversion and indicates an acute primary infection.
Positive	Rise in titre	• A significant rise in antibody titre between early and late phase samples can indicate an active infection. (It does not reveal whether this is the bird's first infection with this agent.) • Rise in antibody titres could also result from booster vaccination or stress-induced reactivation of latent infection.
Positive	Fall in titre	• A fall in antibody titre between the two samplings indicates a previous infection that is no longer active. • A few weeks (2–4 weeks) after vaccination the antibody titre starts to decline continuously.
Negative	Negative	• If both examinations reveal negative results the bird had had no contact to the infectious agent at the time of 1st sampling. Nevertheless, recent infection (within the past week) might have happened without detectable antibodies being present at the time of 2nd sampling.

Thus, seroconversion is more convincing diagnostically than detection of a significant rise in titre.

Appendix 6

Sources of further information

More details on village poultry health and production may be found at the following websites:

- **International Rural Poultry Centre** at <http://www.kyeemafoundation.org/irpc.php>
- **International Network for Family Poultry Development** at <http://www.fao.org/ag/AGAinfo/themes/en/infpd/home.html>
- **Danish Network for Smallholder Poultry Development** at <http://www.poultry.kvl.dk>
- **Australian Centre for International Agricultural Research** at <http://www.aciar.gov.au>
- **Food and Agriculture Organization of the United Nations** at <http://www.fao.org>

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