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Village chickens, poverty alleviation and the sustainable control of Newcastle disease

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Village chickens, poverty alleviation and the sustainable control of Newcastle disease

**Proceedings of an international conference held in
Dar es Salaam, Tanzania, 5–7 October 2005**

Editors: R.G. Alders, P.B. Spradbrow and M.P. Young



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Cover: Vaccination day: community members gather their birds to participate in a Newcastle disease vaccination campaign in a village in Nampula province, Mozambique.

Photo: Robyn Alders.

Foreword

This international conference brought together 102 village poultry researchers and animal health specialists from eastern, southern and western Africa, South-East Asia, Europe and Oceania to share experiences over 3 days in Dar es Salaam, Tanzania, in October 2005. The conference represented both the culmination of 10 years of Australian-supported research into the control of Newcastle disease (ND) in village chickens in southern Africa and the effective collaboration between the Australian Centre for International Agricultural Research (ACIAR) and the Australian Agency for International Development (AusAID).

The proceedings showcase the background, methodology and results of the AusAID-funded Southern Africa Newcastle Disease Control Project (SANDCP), which ran from July 2002 to November 2005. SANDCP built on the ND control research supported by ACIAR from 1996 to 2001 in Mozambique and Tanzania. The ACIAR work in Africa in turn built on over 15 years of research by Professor Peter Spradbrow and his team at the University of Queensland and colleagues in Malaysia, Vietnam, the Philippines and Indonesia.

The proceedings also present a range of topics from the history of the control of ND in village chickens using thermotolerant live vaccine to the role of village chickens in poverty alleviation and HIV/AIDS mitigation. This is testimony to the versatility of village poultry and the wide range of environments in which they are raised. Households now headed by children or grandparents, because of the death of the parents due to HIV/AIDS, raise poultry for sale and home consumption. Livestock such as goats and cattle require shepherds to stay with the herds during the day. This is not possible in households where working adults are no longer present, because remaining family members need to be involved in time-efficient and cost-effective activities in order for the family to survive.

The implementation of an effective ND control program in countries such as Malawi, Mozambique and Tanzania has resulted in increased chicken numbers and household purchasing power, home consumption of chicken products and decision-making power for women; and a higher capacity to survive droughts. ACIAR and AusAID's ND control program is thus expected to have a lasting, positive impact on the livelihoods of many, poor rural women and children in Mozambique, Tanzania and Malawi.



Peter Core
Chief Executive Officer
ACIAR

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Acronyms and abbreviations

ACIAR	Australian Centre for International Agricultural Research	INIVE	National Veterinary Research Institute of Mozambique
ADRI	Animal Diseases Research Institute, Tanzania	kg	kilogram
AIDS	acquired immune deficiency syndrome	L	litre
AusAID	Australian Agency for International Development	m	metre
°C	degrees Celsius	m ²	square metre
DAGRIS	Domestic Animal Genetic Resources Information System	MJ	megajoule
DANIDA	Danish International Development Agency	M&E	monitoring and evaluation
DINAP	National Directorate of Livestock, Mozambique	mL	millilitre
e.g.	for example	MZM	Mozambican metical; old unit of currency
EID ₅₀	50% embryo infectious dose	ND	Newcastle disease
FAO	Food and Agriculture Organization of the United Nations	NGO	non-government organisation
g	grams	OIE	Office Internationale des Epizooties; since 2003, the World Organisation for Animal Health
HIV	human immunodeficiency virus	PRA	participatory rural appraisal
HPAI	highly pathogenic avian influenza	SANDCP	Southern Africa Newcastle Disease Control Project
i.e.	that is (in other words)	SE	standard error
I-2	thermotolerant, live, avirulent ND vaccine	Tsh	Tanzanian shilling; unit of currency
		US\$	United States dollar; unit of currency

The comparative advantages of village or smallholder poultry in rural development

John W. Copland¹ and Robyn G. Alders²

Abstract

Village poultry have been raised for thousands of years and the selection pressure present in the village environment has resulted in local breeds that are well adapted to local conditions. Within the livestock sector, village poultry are often the most commonly owned type of livestock and they are more frequently owned than larger livestock species by resource-poor households. This paper discusses the comparative advantages of village and smallholder poultry in poverty alleviation and food-security projects in developing countries.

Introduction

Poultry have been domesticated for thousands of years; archaeological evidence suggests that domesticated chickens existed in China 8,000 years ago (Alders 2004). They later spread to Western Europe, possibly by way of Russia. Domestication may have occurred separately in India or domesticated birds may have been introduced from South-East Asia. Accounts of cock fighting in India from 3,000 years ago indicate that chickens have been part of the culture for a long time. Domestic chickens appeared

in Africa many centuries ago; they are now an established part of African life. Village poultry can be found in all developing countries and play a vital role in many poor rural households (Alders 2004; Alexander et al. 2004; Copland and Alders 2005; Spradbrow 1993/94). This paper lists and discusses the major comparative advantages of village and smallholder poultry in poverty alleviation and food-security projects.

A flexible production system that can be adapted to many different agroecological zones

Village poultry provide a flexible livestock-production system that is widespread in most African and Asian countries (Alders 2004; Copland and Alders 2005). They are particularly important in the more remote and poorer ethnic groups; for example, in the highlands of Asia, including Vietnam. When agroecological issues and the demographics of the human population are considered, village poultry often rank highly in terms of being an existing resource whose productivity can be increased with only a modest input.

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Low input

Village poultry do not require large investments to start or maintain (Alders and Spradbrow 2001; Alders 2004; Tables 1 and 2). Commercial poultry are found mainly in peri-urban areas. Commercial poultry production needs large capital inputs, considerable technical skill and sophisticated markets. The profit margins of commercial poultry production are likely to drop due to increased costs for better biosecurity, balanced feeds and healthy day-old chicks. Transport costs are increasing, and village poultry raising is better buffered than the commercial sector to accept any cost increases.

The first rung on the livestock ladder

Village poultry can provide the start of the owner climbing the 'livestock ladder', leading to other livestock species such as goats and cattle. This allows a progression of increasing economic activities for poorer people to improve their circumstances (Dolberg 2003).

Low labour requirements

Village poultry are highly suitable for female-headed households (whose number may increase due to civil wars/disturbances and HIV/AIDS) as they can manage and protect their poultry assets

satisfactorily (Copland and Alders 2005; IRPC 2005). The quick return by village poultry to a productive state after a major disaster such as a flood or fire can also be of importance.

Provision of high-quality nutrition

Smallholder poultry provide high-quality animal protein (eggs and meat) at the source of production (Copland and Alders 2005) and households are not reliant on a cold chain as is required for processed commercial birds, meat and eggs. The size of one bird is sufficient for a family, and a cold chain is not required for preservation of 'leftovers'. Village poultry survive where other poultry species would not easily do so.

Income generation

Village/smallholder poultry can provide income for family activities such as education, health and clothes. Village poultry have constantly commanded a price premium over commercial birds and there is a wide market demand for village poultry products. The markets for commercial poultry are focused on large throughput markets, a good distribution system and a relatively long supply chain. The supply chain for village poultry is much shorter; in many cases very short.

Table 1. Comparison of village and commercial chickens (Alders and Spradbrow 2001)

Feature	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; preferred texture	More fat; less flavour; poorer texture
Adaptability	Good: good flight skills, more likely to escape predators, can scavenge for own food	Limited: poor flight skills, easily caught by predators, less skilled at scavenging
Veterinary inputs	None; Newcastle disease vaccination; highly pathogenic avian influenza and fowl cholera vaccination in some countries	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

Table 2. Matching chicken programs with local conditions (adapted from Alders (2004)).

Criteria	Extensive rural production	Semi-intensive/ smallholder production	Intensive smallholder production
<i>Local conditions</i>			
Access to reliable energy supply	No	Yes	Yes
Existence of cold chain	No	Yes	Yes
Feed source	Scavenging; occasional supplementation with locally available feedstuffs	Scavenging; supplementation necessary frequently with commercial ration	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 (frequently use private service providers)	Yes (frequently use private service providers)
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
Other livestock raised	Frequently	Sometimes	No
<i>Inputs required</i>			
Training	Basic: Newcastle disease (ND) control, fowl cholera control (in parts of Asia), poultry husbandry and management	Moderate: control of ND, 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

Gender sensitive

Village poultry are generally owned and managed by women and children and are often essential elements of female-headed households (Guèye 2000; Bagnol 2001).

Low to no environmental impact

Compared with commercial birds and ruminants, village poultry are more environmentally neutral (Alders and Spradbrow 2001). They are well suited to remote areas where there are limited markets.

Robust and agile

Village poultry are better survivors in natural disasters such as floods, tsunamis and fires as they can fly to safety whereas conventional commercial breed birds are generally all lost. In addition, the ability of village poultry to fly and run enables them to be more likely to escape many of their predators (Alders and Spradbrow 2001; Table 1).

Discussion and conclusion

Increased knowledge and capacity gained by women and children through village poultry projects have impacts well beyond the improved village poultry production (Bagnol 2001). When considering development as a whole, increased household food security, income generation and improved nutrition, as well as increased decision-making power for women, are all very important issues.

Village poultry numbers have not declined over the past few decades despite rapid growth in the commercial sector. Over the past 10 years, in spite of a 6–7% growth of the commercial sector, there is still a vibrant smallholder/village poultry sector. The increasing proportion of poultry production by the commercial sector supports the increasing demands of the more urbanised populations, especially in Asia. There is still a large and robust rural population that is active in village poultry in Asia. The demise of village poultry raising in Asia has not happened yet, and may not happen within the next 10 years, giving confidence in investing in smallholder/village poultry. Investment in pilot poultry development projects will have a quick return and positive impact. While highly pathogenic avian influenza is a major issue in Asia at the moment, all livestock species have disease problems, some of which are zoonotic.

Village poultry allow poorer rural communities to convert their major comparative advantage—their labour—into improved food security or cash. This is not easy for other livestock species, as higher capital investments and risks are involved. There are few other opportunities for villagers to utilise their own resources for their welfare and receive a return in a short time frame.

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Fifteen years of family poultry research and development at Obafemi Awolowo University, Nigeria

E.B. Sonaiya¹

Abstract

Family poultry are kept mainly by women. A mean flock size of 16 birds is established by purchase, for the purpose of sale and consumption. Hens mature at 24 weeks and produce 3 clutches of 10 eggs each, 86% of which are hatched, with 33% of chicks surviving. Of the total cost of production to 24 weeks, 61% is for supplemental feed, 20% for replacement stock and 14% for healthcare. A 50% replacement of growers mash by a simple ration consisting of three non-conventional feedstuffs (palm-oil sludge, cowpea testa and maize starch residue) did not affect performance of family birds. Newcastle disease (ND) was identified as the major cause of mortality. On-farm trials indicated that a combination of ND vaccination and feed supplementation increased average daily gain and average clutch size. It was concluded that vaccination, supplementation, and vaccination plus supplementation increased flock size, reduced mortality and increased the number of chicks produced per hen per year. The scavengeable feed resource has been estimated by measurement, calculation and prediction over many years. Genetic evaluation showed three local chicken ecotypes to be superior in disease resistance to exotic Dahlem Red, as indicated by cellular and humoral immune responses. Crosses of Dahlem Red and the indigenous breeds were superior to other crosses but were inferior to the Dahlem Red in all production parameters measured over 5 years. Based on the results of our research and experience from elsewhere, a combination of vaccination, feeding, housing, breeding and farmer training has been developed into a smallholder family poultry model for poverty alleviation and food security for rural people. The model has been field-tested and is at the propagation stage.

Introduction

Family poultry at 104 million outnumber all other livestock in Nigeria (FLDPCS 1992). Commercial chicken holdings account for only 10 million chickens or 11% of the total chicken population of 82.4 million. Family poultry in Nigeria are maintained under low-input, extensive systems of management. These extensive systems incorporate the free-range system, also called the traditional

system, in which birds are free to roam around the homestead; and the backyard system, also called the subsistence system, in which birds are partly confined within a fenced yard (Sonaiya 1995). Family poultry are important as providers of eggs and meat. The production systems—free range/backyard and small-scale intensive—have flock sizes of 1–20 and 10–50 and productivity of 20–60 and 30–100 eggs/hen/year, respectively (Sonaiya 1998). Similarly, each hen can produce 13 kg of meat per year.

Family poultry production systems are economically efficient because although the output from the individual bird is low, the inputs are usually lower.

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This low output is expressed as low egg production, small eggs, slow growth and low survivability of chicks (Smith 1990). But small changes in management, for example, regular watering, night enclosures, discouraging broodiness by regular collection of laid eggs, vaccination against common diseases and small amounts of energy and protein supplements, can bring about significant improvements in production. Such improvements in productivity have been reported under experimental and farm conditions in Bangladesh (Jensen 1996), Burkina Faso (Ouandaogo 1990), Malaysia (Aini 1990), Nepal (Smith 1990), Nicaragua (de Vries 1995), Niger (Bessei 1990), Nigeria (Sonaiya 1990b, 1993a, 1995) and Sri Lanka (Gunaratne et al. 1993).

In socioeconomic terms, the aggregate output of family poultry represents a significant part of the national economy. Annually, it contributes 43% and 89% of the national egg and poultry meat production, with an annual output of 67,000 tonnes of meat and 82,000 tonnes of eggs. These amount to a turnover of US\$149 million from the standing asset of US\$155 million that the family poultry population represents. At the individual household level, family poultry raising represents significant household savings, investment and insurance. It contributes to family income and nutrition. In poor producer families, poultry products are not usually consumed but rather sold when the household is in need of cash. The income from the sale of poultry is an additional revenue to earnings from cash crops from the field. Poultry products that are sold contribute about 15% of the annual financial income of poor rural households. Farmers are willing to save for agricultural equipment or other farm supplies like seeds. Livestock, including poultry, are used as a savings account. The offspring, like chicks, are the interest on the savings.

It can be seen that family poultry production is of importance to the nation and the farm family. Family poultry are as important to the rural areas as are industrial poultry to the urban areas. Under the present circumstances in Nigeria, research and development that increases productivity of family poultry by 10% would contribute far more poultry products than a 10% increase in industrial poultry, which would require far more capital investment. Family poultry are an effective way of transferring wealth from the high-income urban consumers to the poor rural and peri-urban producers. Family poultry development should therefore concentrate

on rural and peri-urban areas, the areas that have been the focus of our research in the past 15 years. In order to solve the problems of family poultry, such as high mortality and low productivity, it is necessary to develop cost-effective improvements for application at the household level. This was the guiding principle for our work.

A research project on family (then called rural) poultry production was initiated in 1987. Our objective was to study the whole system of traditional poultry production and to develop practical interventions for enhancing the productivity, efficiency and profitability of the family flocks. Our studies have incorporated surveys, and on-station and on-farm research.

Socioeconomics and profitability

The initial phase was a series of field surveys carried out at different times in 10 states—Delta, Edo, Ekiti, Kano, Kwara, Lagos, Ogun, Ondo, Osun and Oyo. In 1989, at the Food and Agriculture Organization of the United Nations (FAO)-sponsored International Workshop on Rural Poultry Development in Africa (Sonaiya 1990c), many data obtained from these surveys were presented. The surveys estimated parameters such as number of clutches per year, average clutch size, per cent hatchability and average flock size and composition. More survey data on general management, health and productivity have been collected annually (see, for example, Sonaiya et al. (1992, 1994, 1998b) and Obi and Sonaiya (1995)) and are summarised on Table 1.

We found that women and children provide the labour for family poultry, that only personal sources of finance are used, that majority of respondents wished to expand their flock size to about 200 but are constrained mainly by diseases, lack of capital or technical information, and fear of theft. Other constraints like feed, marketing, labour and land are of decreasing importance in that order. Price fluctuations and market locations are the major marketing problems. More than two-thirds of all respondents used the extensive system, about a quarter used the semi-intensive system and only about 4% used the intensive system. There were about three clutches of 10 (for hens) to 18 (for ducks) eggs per clutch. Hatchability was 85% or more in both species, while replacement value of each clutch was 560% for hens and 1,250% for ducks due to a clutch mortality rate

of 44 and 31%, respectively, occasioned by diseases, predators and accidents.

Less than 5% of respondents had had any contact with poultry extension agents, mainly because most had never seen one nor received adequate responses on poultry from known extension agents who worked with them on their crop farms. The major sources of information on poultry production were radio and neighbours. Other farmers, relatives and market women also provided information.

Mean age of chickens at sexual maturity, number of clutches per year, clutch size and hatchability were non-significantly better in the savanna ecological zones. However, survivability, mortality and marketing were less of a problem in the forest zone. Mean flock size was 14.4 in the forest and 18.7 in the savanna, giving a mean of 16.3 over both zones. The foundation stock was purchased by 73% of the respondents, 10% inherited and 7% were given custody of the birds by others. The purpose for raising family poultry was sale of live birds for 87% of the respondents and sale of eggs by only 3% of the respondents, although 82% of them consumed poultry meat and 19% consumed eggs.

The calculated means of the cost (1992 prices) of supplemental feeding, housing and medication of chickens for 6 months made up 61%, 5% and 14%, respectively, of the total cost of production. The production cost of 4-week-old replacement stock was about 20% of the total cost of production. This was 32% less than the market price of growers. Only 30% of survey respondents purchased replacement stock from the market. The marginal return to labour is very small in family poultry production, being about 6% for a 6-month-old cock. Two practices safeguard the family poultry producers' interest in income from poultry: increasing the age of sale to 1 year instead of 6 months increases returns to about 25%; feeding home-based supplements increases returns to more than 60%.

Surveys (Sonaiya et al. 1992; Obi and Sonaiya 1995) indicated that farmers were willing to pay up to one-sixth the cost of the growers for vaccination and less than 50% of the cost of commercial feed for supplemental feed. As the socioeconomic importance of family poultry production is recognised, thorough economic analysis is required to identify and evaluate problems and plan appropriate interventions for development.

Table 1. Characteristics of family poultry^a flocks in Nigeria

Parameter group	Parameter	Estimate
A. Flock structure	Flock size	16
	Hens:cock	4-7:1
	Growers/flock	50%
B. Hen performance	Age at first egg	6 months (24 weeks)
	Body weight at first egg	900 g
	No. of clutches/year	3
	No. of eggs/clutch	15
	Clutch formation	20 days
	Incubation period	21 days
	Hatchability	80%
	Brooding period/clutch	56 days
Interclutch period	24 days	
C. Flock formation	Mortality (survivability)	30-40% (60-70%)
	Pullets/hen/year	3
D. Nutrition	Daily metabolisable energy intake	110 kcal (0.46 MJ)
	Daily protein intake	11 g
E. Economics	Flock owners on poverty line	70%
	Percentage of family income derived from poultry	15-40

Source: Sonaiya (1990a)

^a Figures for chicken flocks. Some 66% of respondents own chickens only; another 29% have a mixed poultry flock; 2% each own guineafowl-only or duck-only flocks; 0.6% own turkeys only; and 0.4% own geese only.

Feeding and supplementation

Feeding

All family poultry depend on human habitation for their feed, and the ratio of poultry to farming population is usually about 1:1.3. Free-range birds do not receive sufficient feed but survive through scavenging. Here, energy is the first limiting nutrient as the food available on the range contains a lot of crude fibre. During grain harvests, birds can usually scavenge enough energy feed but not in the hunger season. During the rains, they get abundant animal protein by picking up worms, snails and insects. Ayeni (1982) reported that the food of the helmeted guineafowl in nature consists of 35% grass seeds, 21% insects, 17% cyperus bulbs, 13% fruits, 9% leaves, 2% pebbles and 3% water ingested with food.

Insects are important in the diet of all scavenging poultry. This is why energy supplements, no matter how unbalanced, increase production. Sonaiya (1993b) used successfully as a supplement for scavenging chickens an unbalanced ration containing 11% crude protein and 3,800 kcal metabolisable energy/kg (15.9 MJ/kg), which could not serve as a maintenance ration for confined cockerels. Intake of supplementary feed at a rate as low as 8 g/day increased body-weight gain of scavenging grower chickens. Substantial research information is now available (see the review by Sonaiya (1995)) to design adequate feed supplements and to demonstrate their economic efficiency.

Scavenging chickens easily develop vitamin and mineral deficiencies in the dry periods. These are signalled by comb and skin rashes. Giving ashes, pounded shells and wilted greens provides some of the minerals and vitamins they need. It can be seen that the low production of scavenging chickens may not be due to lack of inherent ability but to variable seasonal imbalance in the diet: low protein, vitamin and mineral during the dry harvest period and low energy during the late dry season and the rainy period.

Supplementation

One important area of regular intervention in the scavenging system is grain supplementation. Maize and sorghum, the grains of choice, are now used by flour mills, breweries and other food industries with which scavenging chickens cannot compete. There is thus the need to evaluate those non-conventional feed ingredients that are available at village level and that can be used in place of grains.

A collection of 25 non-conventional feedstuffs was analysed for proximate composition, sugar and starch contents, and apparent metabolisable energy of each sample was calculated using the equation of Carpenter and Clegg (1956). The values (e.g. Table 2) obtained for proximate fractions agree with those of Gohl (1975). Three such feedstuffs—palm (*Elaeis guineensis*) oil sludge, cowpea (*Vigna unguiculata*) testa and maize (*Zea mays*) starch residue—were available in the largest quantity because they are by-products of cottage industries in south-western Nigeria. The voluntary daily intake by cockerels of commercial growers mash, maize-starch residue, palm-oil sludge and cowpea testa was 44.2, 43.2, 10.7, and 10 g dry matter, respectively. The intake of commercial growers mash was similar to that of maize-starch residue, and higher ($P < 0.01$) than the intake of palm-oil sludge and cowpea testa.

In a growth trial, daily feed intake and gain were similar for cockerels on 0% and 50% of the three feedstuffs mix. However, birds on 100% of the mix had very poor intake and steadily lost weight. The results indicate that diluting the commercial ration with 50% of these non-conventional feedstuffs would not affect the performance of cockerels raised in cages (Idowu 1992). However, birds could not subsist on 100% non-conventional feedstuffs as the chemical composition of this diet was very different from that of the commercial ration and from recommended allowances for growers in the tropics (Olomu 1979; Singh and Panda 1988).

In an on-farm study, 10 scavenging flocks in two selected villages with a total of 165 chickens (55 adults, 57 growers, 53 chicks) were allotted to supplementation treatments of 0 g, 30 g and 60 g of 100% non-conventional feedstuffs/bird/day. Supplementation below 60 g/day was insufficient to increase the growth rate of adult birds, while supplementation at 30 g/day enhanced the growth of chicks ($P < 0.05$), possibly because chicks are not as good in scavenging as older birds (Sonaiya 1993b).

The following conclusions were drawn:

1. Non-conventional feedstuffs available in the villages are promising supplements for scavenging chickens, based on their chemical composition.
2. Palm-oil sludge, cowpea testa and maize-starch residue singly or in composite rations can be used as supplements for scavenging chickens.
3. A 50% dilution of proprietary feed by the three feedstuffs is acceptable to backyard chickens

without a significant loss in performance but with significant reduction in feed cost.

4. The 100% non-conventional feedstuffs ration is acceptable as a supplement to scavenging chickens.
5. Supplementation below 60 g/bird/day is insufficient to increase the growth rate of scavenging adult birds, while the growth of scavenging chicks (i.e. <100 g body weight) increases with a rate of supplementation of 30 g/bird/day.

Health management

High mortality and high parasite load due to inadequate housing and health care are problems of extensive poultry production. Many diseases plague family poultry including Gumboro, coccidiosis, fowl pox, fowl typhoid, fowl cholera and pediculosis (Adene 1990). Less than 4% of respondents use veterinarians and, instead of treating the birds, most will either do nothing (12.5%), kill diseased birds (12%) or sell them (6.8%). Culling of birds is indexed on cash needs, old age of the birds, and sickness or other reasons such as the need for sacrifice. Poor productivity is used by less than 25% of

respondents as an index for culling. Newcastle disease (ND) is the most important disease and it causes very high mortality. The disease is predominant in chickens and is most common in the dry and cold months (November–January). Hence, vaccination against ND is an obvious priority.

A series of on-farm studies focused on the effect of vaccination against ND and of offering a supplement of commercial growers mash on the productivity of scavenging village chickens. The results (Table 3) indicated that there was an about 50% increase in growth rate, a 12.5% increase in number of eggs hatched, a 10% increase in chick survival and an about 40% reduction in mortality with vaccination alone. Chickens on the vaccination plus supplementation treatment had the highest average daily gain of 4.55 g/bird/day, which was 65% higher than the gain of birds on the control treatment (2.75 g/day). The average clutch sizes of hens on the supplementation and vaccination plus supplementation treatments (9.3 and 8.8 eggs) were significantly higher than the clutch sizes of hens on the vaccination and control treatments (6.7 and 6.3 eggs). Chick survival was highest (93%) in the vaccination plus supplementation treatment and lowest (76%) in the

Table 2. Composition of some non-conventional feedstuffs for poultry

Feedstuff	Composition (%)					
	Dry matter	Crude protein	Ether extract	Crude fibre	Ash	Calculated metabolisable energy (kcal/kg dry matter) ^a
Leaves						
<i>Talinum triangulare</i>	10.0	23.9	4.0	9.6	19.7	923
Seeds						
<i>Carica papaya</i>	14.2	27.4	0.4	27.2	3.6	1,308
<i>Talinum triangulare</i>	43.5	18.6	5.0	20.6	4.2	1,362
<i>Amaranthus graecizans</i>	65.1	16.0	0.2	5.5	3.2	922
Testa						
<i>Glycine max</i>	28.6	16.6	4.0	25.4	2.7	2,096
<i>Vigna unguiculata</i>	24.4	17.0	2.6	20.3	1.5	1,005
Pulp						
<i>Carica papaya</i>	13.4	6.5	0.9	6.0	4.0	3,396
<i>Citrullus vulgaris</i>	43.0	4.3	8.6	31.1	20.6	1,148
Processing by-products						
Palm-oil sludge (<i>Elaeis guineensis</i>)	30.2	4.3	53.2	7.5	7.2	5,680
Maize-starch residue (<i>Zea mays</i>)	21.6	16.8	7.8	4.2	0.5	1,642

Source: Sonaiya (1995)

^a 1 MJ = 4.2 × 10³ kcal.

control treatment (Sonaiya et al. 2002). In summary, vaccination, supplementation, and vaccination plus supplementation treatments consistently increased flock size, reduced mortality and increased the number of chicks produced per hen per year.

Genetic improvement

Many types and varieties of family poultry are usually differentiated by feather colour and other external characteristics. Some, however, are reported to possess other characteristics that are of economic importance. These include ability to handle fibrous feeds, pronounced sexual dimorphism in favour of the male (e.g. geese and Muscovy ducks) and possession, by chickens, of the genes that affect adaptability and productivity in hot climates. Examples are the genes for bare or featherless neck—Abolorun (Yoruba) or Pingi (Hausa), dwarf body type (Arupe or Durugu) and frizzled feather (Asa or Shazumama). While most of these varieties

have yet to be developed into pure breeds, there have been attempts at selection. Olori (1991) from the family poultry research project team indicated that the chickens of the pastoral Fulani or Bororo of Nigeria have been selected for meat and hardiness. Considerable work has been done (Nwosu 1990) on the crossbreeding of local breeds with exotics.

Between 1992 and 1997, the family poultry research team participated in a cooperative research project funded by the European Commission's Science and Technology Development Programme. Our particular aim in Nigeria, within the larger project objective, was to evaluate how local poultry populations vary in their ability to resist diseases and in their productivity. Some 28 populations (1,570 local birds and 1,192 exotics) were evaluated over 72 weeks on the university teaching and research farm, for physical appearance and production performance traits—age at first egg, egg production and egg weight, percentage hen-day egg production and percentage laying mortality. We also searched

Table 3. Effect of vaccination and feed supplementation on performance of scavenging chickens in Nigeria

	Treatments			
	1	2	3	4
Total mortality (%)				
Study 1	35	27	57	65
Study 2	19	5	12	2
Mean	27	16	35	34
SEM	2.38	2.79	3.99	4.72
Clutch size				
Study 1	6.7 ^b	9.3 ^a	8.8 ^a	6.3 ^b
Study 2	6.8 ^a	6.2 ^a	6.4 ^a	8.8 ^a
Mean	6.7 ^a	7.7 ^a	7.6 ^a	7.5 ^a
SEM	0.19	1.05	0.92	0.94
Percent hatchability				
Study 1	82	68	81	66
Study 2	91	84	83	89
Mean	87	76	82	78
SEM	1.78	2.38	0.84	2.85
Percent chick survivability to 2 weeks				
Study 1	81	77	91	54
Study 2	87	96	95	98
Mean	84	86.5	93	76
SEM	1.46	2.59	1.19	3.94

Source: Sonaiya et al. (2002)

Treatments:

1 = vaccination only

2 = feed supplementation only

3 = combination of vaccination and feed supplementation

4 = no vaccination or feed supplementation

^{ab} = means in the same row with different superscripts are significantly different ($P < 0.05$)

for genetic differences between collections from ecological zones in Nigeria—Kaduna and Jos from the Guinea savanna, Makurdi and Ilorin from the derived savanna and Nsukka and Sagamu from the rainforest zones. For all the traits, there was no significant difference between the chickens from the three ecological zones. Hence, the local chickens from these zones do not belong to different genetic groups (Adedokun and Sonaiya 2001).

Investigation of the disease-resistance status of local birds was carried out using 20 birds per ecotype. Humoral immune responses were measured by haemagglutination inhibition test using sheep red blood cells. Cellular immune response was assayed by delayed hypersensitivity test (skin test). For genetic upgrading of local populations, purebreds and F₁ crosses between local and Dahlem Red (DR; a German strain of the Rhode Island Red) populations were produced. The locals, DR and their F₁ crosses were evaluated for various performance traits (Table 4). The results showed that the local chickens were immunologically superior to the DR and that there were differences between chickens from different ecological zones (Sonaiya et al. 1998a). The local ecotypes and their crosses with DR were, however, inferior to the DR at 20, 40 and 72 weeks of age, in shank length, body weight and egg production (Adedokun and Sonaiya 2002). The genetic distances determined by genotyping based on 20 micro-satellites, ranged from 0.05 to 0.16 within the ecotypes but were 0.32 to 0.38 between the mean of the ecotypes and the DR (Wimmers et al. 1999).

Family poultry research and extension requirements

1. Feed

There is a need to intensify the search for new feed resources to replace grains that are not cost-effective under the prevailing economic situation. Since yams and cassava have higher productivity in the humid tropics than all the grains, effort should be directed at producing feed-grade ingredients from these tubers. Such ingredients should be grain-like (e.g. gari from cassava) to facilitate their use in traditional feeding systems as well as in feed milling. If such grain substitutes can be coated or impregnated with proteins, vitamins and vaccines, they can become a complete supplement for family poultry production.

2. Extension

Group marketing has advantages. The dynamics, management and viability of family poultry groups should be studied. Radio was identified as the most important means of obtaining technical information. Families would be well served by radio programs devoted to the provision of information for poultry development.

3. Health

Appropriate vaccination protocols and housing systems must be developed.

4. Genetics

Selection for adaptive traits has been achieved in the development of the Shika Brown Layer by the National Animal Production Research Institute.

Table 4. Egg production, immunity and heterozygosity of local chicken collections and exotics

Population	Mean age at first egg (days)	Egg weight (g)	Egg number	Immunity	Mean heterozygosity
Kaduna	153 ± 14	41 ± 4.5	94 ± 16	0.5 ± 0.02	0.59 ± 0.27
Ilorin	150 ± 16	38 ± 1.5	80 ± 22	1.0 ± 0.02	0.50 ± 0.23
Makurdi	166 ± 15	41 ± 4.2	101 ± 25	-2.0 ± 0.05	0.57 ± 0.20
Jos	169 ± 14	36 ± 3.5	97 ± 15	1.0 ± 0.03	0.60 ± 0.33
Sagamu	167 ± 20	40 ± 3.4	84 ± 21	0 ± 0.01	0.57 ± 0.29
Nsukka	162 ± 17	38 ± 2.5	104 ± 24	-0.5 ± 0.03	0.59 ± 0.24
DR	159 ± 14	58 ± 4.6	143 ± 14	-2.0 ± 0.01	0.49 ± 0.22
SBL	138 ± 10	49 ± 2.0	182 ± 11	Not tested	Not tested

Sources: Sonaiya et al. (1998), Wimmers et al. (1999)

DR = Dahlem Red; SBL = Shika Brown Layer.

Carefully controlled studies to compare the effects of seasons, location and management on the Shika Brown Layer in the savanna and forest zones have been carried out nationally. Our team carried out an evaluation of the breed over 2 years in the subhumid zone. Our studies showed that the Shika Brown Layer was clearly superior to the local ecotypes and the DR in body-weight gain and egg production and in laying persistence, respectively (Sonaiya et al. 1998a).

Family poultry development strategies

The effort to develop family poultry in the rural areas started in Nigeria as far back as 1919 (Sonaiya 1989). Various schemes have been implemented but most had used a single (mostly genetic) improvement approach rather than a combined improvement approach. Hence, the most widespread strategy was cockerel exchange.

Genetic improvement approach

Theoretical studies (ter Horst 1987) showed that cockerel exchange is less effective and more expensive than other genetic-improvement strategies such as distribution of fertile eggs or chicks of improved breeds. In Comoros, the cocks of the Egyptian Dokki (itself a Fayoumi × White Leghorn cross) and hens of the indigenous 'Fermiers' (the locals) were used, but there was high mortality of breeder stock and great variability in the F_1 and F_2 offspring (Kassimo 1990).

In Sudan, cockerel exchanges were mounted in 1928 and 1956 for three consecutive years each, but upgraded stock was susceptible to disease and not adaptable to traditional poultry management. Distribution of hatchable eggs was then used, but this was hindered by low hatchability under natural breeding and the difficulty of distributing hatching eggs in rural areas. Attempts at distribution of day-old chicks failed due to limitations of breeding stock, hatching and brooding facilities, the high cost of chick production and difficulty in distribution. Earlier, selection of indigenous cocks based on phenotypes had to be abandoned as it did not increase egg production (El Zubeir 1990; Musharaf 1990).

The Black Australorp Village Poultry Improvement Programme initiated in Malawi in 1969 sold 320,000 6-week-old growers of both sexes to

farmers every year, but the results were not evaluated (Upindi 1990). In The Gambia, cockerel exchange using Rhode Island Red failed due to improper control of ND. On the other hand, the pilot Rural Poultry Improvement Programme in the Upper River division engaged in disease control, information dissemination through farmer training, construction of poultry houses, use of locally available feed and development of marketing outlets for birds and eggs. This was so successful that the World Bank's Women In Development Project replicated the package in 200 villages throughout the country (Andrews 1990).

In Kenya, the National Poultry Development Programme, a joint venture between the governments of Kenya and the Netherlands, started cockerel exchange in 1977 and by 1989 had increased egg production by 52% (Mbugua 1990). A pullet exchange program was also initiated in 1985 but has not yet been evaluated. It should be noted that the program has always been involved in applied poultry research, marketing studies and training and extension. It has been very successful in training poultry production specialists who now serve as poultry production officers in most districts. This successful approach has been continued by the National Dairy Cattle and Poultry Research Programme, which is also supported by the Dutch and had been focused exclusively on family poultry research (Sonaiya 1998).

Combined improvement approach

Wherever genetic improvement strategies have been combined with vaccination, feeding, housing improvement or farmers training, better success has been achieved. Even the short-lived United Nations Development Programme/FAO-sponsored Poultry Development and Extension Project started in Somalia in 1989 introduced to 100 women ND vaccination, improved cleanliness and ventilation of poultry housing, protection of chickens for the first 8 weeks and provision of supplementary feed (Ahmed 1990). The North Togo project in the Kara region combined cockerel exchange with ND vaccination, shelter and feeding improvement (Aklobessi 1990).

The Rural Poultry Programme of the Christian Rural Service of the Church of Uganda had cockerel exchange and improvement in poultry management skills as its objective. One of the few programs to be evaluated, it was deemed successful in developing

interest, but only participants with good hen houses and feed obtained increased egg production and flock size. Government veterinary services provided drugs and vaccines, prepared recipients of cockerels and gave management advice (Olaboro 1990).

The Bouake Poultry Extension Programme in 34 villages in Katiola and Dabakala counties of Côte d'Ivoire was initiated in the late 1980s. Major program actions were meetings, demonstrations and free provision of vaccines, chicks and cockerels. Extension messages were developed on provision of night shelters, use of litter, distribution of poultry products and ad libitum water provision. It has increased average egg production by 25%, decreased chick mortality from 50% to 20% and reduced adult mortality (Boye 1990).

Prospects for the combined approach

This combined approach to family poultry development can also run into problems as it did in Cameroon. In 1981, the Office Nationale pour le Développement de l'Aviculture et du Petit Betail was created with the mandate to produce and distribute 6 million improved day-old chicks and 50,000 tonnes of feed, supply veterinary drugs, and process and package poultry products (Ngoupayou 1990). It faces technical and managerial problems not unrelated to its nature as a government parastatal. This points to a shift toward the use of cooperative, non-governmental, or farmers associations to provide input services.

In Senegal, the 'Sauvegarde de l'Aviculture traditionnelle' campaign started in 1991 was intended to carry out a baseline survey, to train village auxiliaries to vaccinate against ND and fowl cholera, and to organise and train village poultry producers economic groups in poultry management and in the collection, slaughter, processing and sale of poultry products. Similarly in Zaire, the Programme de Sante Animale de Base started in 1989 with World Bank assistance involved village associations in nominating village vaccinators for training.

Two countries have achieved outstanding success in family poultry development—Bangladesh and Burkina Faso. The famous *Projet pour le Développement Aviculture Villageois (PDAV)* in Burkina Faso, funded by *Coopération Française*, concentrated on the training and placement of 'vulgarisateurs villageois volontaires' (VVV), although its broad objective was improvement in hygiene,

housing and feeding of family poultry, and in the transport and marketing of its products (Ouandaogo 1990). In 10 years (1979–1989), 1,821 VVV were trained, and they administered 13 million ND vaccinations and 1.2 million anti-helminth treatments, among others. It is estimated that, in 3 years, the program resulted in the production of 1 million additional poultry. The last years of the program were devoted to training and retraining of VVV and publicity campaigns through slide shows in villages, debates in schools, pamphlet distribution, VVV meetings, farmer visits to livestock centres and technical conferences of livestock agents. This large program covered 15 provinces (of 30 in the country), 4,378 villages (7,500) and 5,646,125 beneficiaries. A major factor responsible for the success of this program was the political will and commitment of the government to rural development in general and agriculture in particular (Sonaiya 1992).

In Bangladesh, the government Department of Livestock Services and the Bangladesh Rural Advancement Committee, a non-government organisation (NGO), have over the past 20 years focused on family poultry as a vehicle for providing employment and socioeconomic development for rural peoples. Their Semi-scavenging Poultry Model, funded so well by the Danish International Development Agency (DANIDA) and many other donors, has reduced the poverty level by 32% per year amongst the poorest of the landless poor (Alam 1997).

Family poultry development requirements in Nigeria

Development of family poultry production, which accounts for 80% of the poultry population, will significantly improve family nutrition and incomes, employment opportunities and promote equity for women. World Bank projects have shown that small poultry farms can be competitive, especially when using low-cost by-products (de Haan 1992).

Where there is a consistent government policy to support the economic advancement of the family, family poultry development has succeeded. Family poultry development has been found to be ideal for rehabilitation of refugees and victims of disasters and wars. Somali nomads, who lost most of their cattle to drought, accepted poultry and poultry products as substitutes for cattle and beef, respec-

tively. Widows of the Ugandan civil war were rehabilitated by the Catholic Church of Uganda through a rural poultry program initiated in 1987.

In Nigeria, the federal and state governments have policies promoting agriculture as a vehicle for poverty alleviation, food security, employment creation and expansion of the private sector. Generally, family poultry production has received insufficient attention. This is due more to the lack of access to the available information and development ideas for this subsystem in the complex farming system. FAO and the world poultry community now recognise that development of family poultry requires a multifaceted intervention in vaccination, housing, feeding, marketing and genetic improvement. Both public and private involvement are necessary. Government livestock institutions (including universities and research institutes) must agree to be involved in:

- training of trainers in poultry production (poultry subject matter specialists) who will then train village extension agents and farmers
- carrying out applied research, particularly in the use of locally available housing materials and non-conventional feedstuffs
- production and delivery systems for vaccines and health intervention
- production of improved breeding stock.

The private sector (including for-profit and not-for-profit NGOs, cooperatives and village associations) should be developed and entrusted with the tasks of (Sonaiya 1992):

- production of vaccines, pharmaceuticals, feed and housing materials
- training village operators (vaccinators, extension agents, input suppliers etc.)
- distribution of vaccines, drugs, feed and housing materials
- the assemblage, processing and marketing of products.

These paradigms, along with our research results, were brought into focus by the first-hand experience with the Bangladesh Semi-scavenging Poultry Model. Our constant interaction with family poultry producers and with members of a trade union, the National Union of Local Government Employees, contributed to the development of the Smallholder Family Poultry (SFP) Model for Nigeria. The general objective of the SFP Model is to enhance the income earning capability of very poor women. The Nigerian SFP Model provides an entry point for

these very poor women to diversify income earning and employment opportunities and, through training in poultry activities, to improve their socioeconomic situation.

The specific objectives are to:

- enable village women, through SFP rearing, to earn a monthly income of N500 to N5000 (US\$4–US\$40)
- supply birds of high-yielding varieties (e.g. Shika Brown Layer) to upgrade the local birds and so increase their production of eggs and meat
- prevent common poultry diseases and reduce mortality from 40–85% to 15%
- train SFP owners in improved scavenging-based rearing
- provide micro-credit and technical services through government agencies and NGOs for SFP enterprises suitable to the hard-core poor.

The SFP Model is currently undergoing field testing, adaptation and adoption in different forms in several states of the federation.

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Thermostable vaccines in the control of Newcastle disease in village chickens: a history

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Abstract

Important events that preceded the Southern Africa Newcastle Disease Control Project (SANDCP) project are considered. Severe Newcastle disease (ND) was first described in the accessible scientific literature in the late 1920s. The disease rapidly spread around the world. Milder unremarked forms of the disease may have been present before this, with possible earlier severe episodes in Asia and Africa escaping historical notice. The developing commercial poultry industry at that time was obliged to come to terms with this devastating disease. Flocks of village chickens had no protection from it.

Early studies on the causative virus depended on transmission to chickens. In the 1930s, it was shown that the virus could be cultivated in embryonated eggs and that the virus could be easily quantitated by measuring its haemagglutinin. A simple haemagglutination inhibition test detected and titrated anti-viral antibody. These tests are still basic to studies on ND virus.

Vaccines for use in commercial flocks were produced by the standard contemporary approaches for the control of serious veterinary diseases. Crude inactivated vaccines were produced first, then virulent virus was applied together with antiserum. A later refinement was the use of viable attenuated vaccines. These have served the commercial industry well but they have found little use in village chickens. There has been no tradition of vaccination in village flocks. The commercial vaccines have been too expensive and insufficiently robust for rural flocks.

Unusual, avirulent strains of ND virus have been recognised in Australia since 1966. The first isolate, strain V4, was later developed as a commercial vaccine. When the Australian Centre for International Agricultural Research (ACIAR) was founded, an initial project (in 1984) was to develop a ND vaccine suitable for use in village chickens. The first trials, conducted jointly by the University of Queensland and the Universiti Pertanian Malaysia, used variants of strain V4, artificially selected for enhanced heat resistance. Following successful laboratory and field trials, ACIAR supported a regional approach, with confirmatory studies in Indonesia, Philippines, Thailand and Sri Lanka.

In the initial trials, V4 vaccine was presented to chickens on food. This was a concession to the lack of physical control over the chickens at the time. Eye-drop vaccination has proved more effective and is now advocated where husbandry conditions are favourable.

When V4 became a commercial vaccine, a new vaccine strain was required for village use, to avoid legal complications. ACIAR sponsored the development at the University of Queensland of a new vaccine master seed. The result was strain I-2, another Australian avirulent virus that had properties, including heat resistance, similar to V4. The master seed, controlled by ACIAR and held at the University of Queensland, is available without cost to developing countries.

Tests with the heat-resistant vaccines V4 and I-2 have been undertaken in many countries in Asia and Africa. Some of the countries have adopted one or other of these vaccines and produced them on a large scale. Vietnam is a particular example where local initiative has seen full exploitation of the vaccine.

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Agencies other than ACIAR have become involved in the projects, supporting vaccine activities in country or training projects at home or in Australia. These agencies include the Food and Agriculture Organization of the United Nations, the United Nations High Commission for Refugees, the World Bank, the International Atomic Energy Agency and the Australian Agency for International Development. Many non-government organisations have been supportive.

Vaccine production and testing was only the foundation for the successful projects. Sustainable vaccination campaigns have required in-country vaccine production, and this depended on appropriate training at international workshops or at the University of Queensland.

Also essential to the success of the project has been the development of new extension materials and activities. These have targeted all the stakeholders—the women who are the traditional keepers of village chickens, the people who will do the vaccinations, and all the levels of bureaucracy where pertinent decisions are made. Dr Robyn Alders in Mozambique has initiated and developed much of this material.

Introduction

The Southern Africa Newcastle Disease Control Project (SANDCP), which is the subject of the present workshop, commenced in 2002. This introductory paper considers events that preceded the SANDCP. The author was associated with many of the activities that culminated in the decision of the Australian Agency for International Development (AusAID) to support large-scale production and distribution of I-2 vaccine to control Newcastle disease (ND) in village flocks in Malawi, Mozambique and Tanzania. Hundreds of people have been involved in the initial studies that allowed the development of heat-resistant ND vaccines and demonstrated their efficacy.

Veterinary and virological interest in ND virus dates from the 1920s. Early studies included the development of vaccines, and vaccines are a continuing enterprise. In Australia, vaccine studies became possible after 1966 when it was demonstrated that avirulent strains of ND virus were endemic in local flocks. Until then, ND was not recognised in Australia except for a brief incursion in the 1930s. The commercial poultry industry sponsored the first vaccine trials with the new virus, strain V4. Later, when the Australian Centre for International Agricultural Research (ACIAR) initiated projects on protecting village chickens against ND, V4 was available as a potential vaccine. ACIAR support continued for some 15 years, and other national and international agencies eventually became involved.

I have tried not to overload this offering with references. References have been limited to reviews, proceedings and research papers that made essential contributions to progress. Greater detail and

extensive reference lists are available in two previous reviews (Spradbrow 1993/94, 1999).

Where did Newcastle disease come from?

Historians try to establish starting points for their histories. With what event do we start a history of ND? For readers of the English language the initial study is usually accepted as that of Doyle (1927). He described a 'new' disease of chickens that occurred at Newcastle-upon-Tyne in the UK during the previous year. He was able to distinguish it from the major infectious disease of chickens recognised at that time and called fowl plague. The causal virus of fowl plague was eventually shown to be an influenza virus and the disease is now called avian influenza. ND also entered the Dutch literature, with outbreaks, also in 1926, at sites in present day Indonesia. The new disease spread rapidly to involve the developing chicken industries in many countries.

Lancaster (1966) has written an interesting account of the documented early spread of ND. He postulates that there may have been earlier outbreaks that were not adequately described. Of interest to the present audience, Lancaster mentions suggestions that a disease that may have been ND was transmitted from Asia to Africa in the mid 19th century. This speculation originated in two cited reports, in Portuguese, from veterinary institutes in Mozambique. It would be of interest to know if these reports from 1950 and 1961 still exist.

We know now that ND presents in several clinical forms. It is possible that only severe epizootics attracted early attention and that milder forms of the disease had long been present in small chicken

flocks. Increase in virulence could be attributed to changes in the virus or to changes in husbandry of commercial chickens. It seems certain that the early spread of the disease was facilitated by movement of live birds by land and by sea.

The Australian story

For many decades Australia was presumed to be free of ND. The disease had entered during the pandemic spread in the 1930s but had been eradicated by the classical methods of detection of infected or potentially infected flocks and slaughter. The causal virus, usually termed the Albiston Gorrie strain, was isolated and preserved. This is probably the oldest strain of ND virus still available.

In Australia Dr (later Sir Macfarlane) Burnet undertook studies on the Albiston Gorrie virus. He showed for the first time that ND virus could be cultivated in fertile hen eggs and that the virus present in allantoic fluid could be detected by a simple haemagglutination test. He further found that a simple haemagglutination inhibition test served to detect anti-viral antibody. Some 60 years later we still rely on these tests in our studies of ND virus. Burnet also demonstrated that ND virus could produce conjunctivitis in infected people.

With the eradication of the original outbreaks and the confinement of the Albiston Gorrie strain to a few laboratories, Australia enjoyed three decades without ND. In 1966, Simmons in Brisbane (Simmons 1967) isolated an unusual strain of ND virus from a local chicken. This virus, strain V4, was less pathogenic than even the mildest vaccine strains used in other countries. It caused no clinical signs when it spread between chickens by natural routes, it did not kill inoculated embryos and it produced few cytopathic changes in cultured chicken cells. ND viruses with these properties are now termed 'avirulent'. My group and other workers soon found that such avirulent viruses were widespread in Australia. They had probably been present for some time but were unrecognised because they caused no disease.

There were two consequences. First, because the importation of any live ND virus into Australia was forbidden, the commercial industry had no access to vaccines. Australian virologists could now investigate strain V4 as a vaccine. These studies were restricted to antibody responses, except in one high security laboratory that was permitted to use the Albiston Gorrie strain as a challenge virus. Other

work had to be done overseas where virulent challenge viruses were available. My own studies were undertaken with colleagues at the Universiti Pertanian Malaysia. An excellent cooperative understanding was developed. V4 proved to be a proficient vaccine, eventually going into commercial production for the commercial industry.

The second consequence was a renewed interest in ND virus by basic virologists. Here was a single virus that, in nature, supported strains that varied greatly in virulence. Some produced no clinical signs while others would kill all infected birds. Medical virologists with an interest in pathogenesis were fascinated.

I had suggested to industry in the late 1980s that the danger with ND in Australia was probably from a gradual increase in the virulence of our endemic viruses. The accidental introduction of virulent, foreign viruses seemed a lesser risk. My team looked at a collection of 45 contemporary Australian isolates but found none to cause disease in chickens (Spradbrow et al. 1995). These 45 isolates contained the strain now known as I-2. Soon after this, our local strains did change, being associated at first with other agents in the production of mild respiratory disease and finally causing clinical ND. This was eradicated by conventional methods.

Recently developed techniques in molecular virology have allowed a partial explanation of the changes in virulence. Sequential genetic alterations can be mapped. Differentiation of virulent virus, progenitor virus that requires only a minor genetic change to become virulent, and the background V4-like viruses is now possible in the laboratory. With the elimination of the virulent virus, vaccination with V4 vaccine is used to suppress the progenitor virus.

Newcastle disease vaccines for village use

Commercial ND vaccines have been a success in commercial flocks. Usually these contain attenuated strains of ND virus grown in the allantoic cells of chicken embryos and collected in the allantoic fluid. The eggs are derived from specific-pathogen-free (SPF) flocks. These flocks are maintained behind secure microbiological barriers and tested rigorously for freedom from a large range of infectious agents. Vaccine seed and vaccine are also tested for absence of these agents. SPF eggs are costly and in short supply, adding to the cost of commercial vaccines.

Large commercial flocks require large amounts of vaccine. The vaccine producer can present the vaccine in large dose formats (at least 1,000 doses per ampoule of freeze-dried product) thus minimising cost to commercial producers of chickens. Industry has no problem in arranging refrigerated transport and storage of vaccine (the so-called cold chain) so there has been no incentive to counter the inherent heat lability of these vaccines. Commercial vaccines are delivered, often in drinking water or by various forms of spray, to large, single-age flocks under excellent physical control.

These sophisticated vaccines rarely reach village flocks, which are small, multi-aged and scattered. The chickens range freely during the day and are not always confined at night. Cold chains are rarely available. Commercial packaging makes the vaccines too large for village flocks and too expensive for village farmers. Governments have been unwilling to use foreign exchange to import avian vaccines.

The culture of village chicken production has not been conducive to vaccination. The owners of the chickens are usually village women—already overworked, often illiterate and neglected by government agencies. Extension workers have favoured ruminant animals and the men who manage them.

When ACIAR started to support research activities in 1984 a major problem that came to their notice was that of ND in village flocks. In many developing countries ND was the greatest impediment to productivity of rural chickens. ACIAR asked Professor Latif Ibrahim of the University Pertanian Malaysia and me whether we could produce a vaccine suitable for village use. We had previously collaborated on developing V4 as a vaccine for commercial chickens. We saw the need for a new vaccine appropriate for the task, rather than trying to utilise the existing commercial vaccines with the deficiencies noted above.

We suggested:

- producing a new vaccine based on V4. We knew that V4 was relatively heat resistant and a highly heat-resistant variant had already been selected in my laboratory.
- delivering the vaccine on food. Village chickens in Malaysia at that time were rarely housed.
- selecting a vaccine that would spread between chickens. Chickens can cheaply vaccinate other chickens.

- producing vaccine locally. Imported vaccine would not be sustainable.
- using non-SPF eggs. We could make a safe vaccine in eggs from a well-managed farm.
- accepting a moderate level of protection. Vaccination under village conditions could not yield 100% protection.

The initial ACIAR projects

The concept for a project to develop appropriate vaccines to control ND in village chickens arose from discussions between Dr John Copland of the newly formed ACIAR and Professor Latif Ibrahim from the new veterinary faculty in the Universiti Pertanian Malaysia. I became involved because of previous collaborative work with the Malaysian group on V4 vaccine. Australia, a country then free of clinical ND, had a history of work with the virus. Further experience of Australian workers with ND vaccines could only be of benefit to the local commercial industry.

The first project involved only groups from the Universiti Pertanian Malaysia and the John Francis Virology Laboratory at the University of Queensland. Our initial vaccines were variants of strain V4 selected for enhanced heat resistance. In Queensland we concentrated on the serological response of chickens to vaccination and on the ability of the vaccine virus to spread between chickens.

In Malaysia it was possible to conduct challenge experiments. I have always advocated that challenge with virulent virus should be by contact with infected chickens, as occurs in the field. The Malaysian heat-resistant variant of V4 was shown to protect laboratory chickens and village chickens kept under laboratory conditions. Initial studies were on food-delivered vaccines, carried first on food pellets and later on wheat grains.

The concept of a food-based vaccine for use in chickens was innovative. At the time no avian vaccine had been delivered on food. Precedents were the use of baits containing rabies vaccine to vaccinate wildlife, and some human poliomyelitis vaccine was given orally. The initial experiments were very encouraging.

The culmination was a large field trial conducted by Aini Ideris (then a PhD student, now Professor Aini Ideris) on the east coast of Malaysia. Chickens vaccinated by farmers were purchased and returned to the laboratory for challenge. Control chickens

were drawn from unvaccinated villages. Some 60% of the vaccinated chickens survived the challenge that killed all control chickens. Similar results were obtained in three trial villages and three control villages (Aini et al.1990).

The V4 vaccines used in this and subsequent trials came from various sources. Heat selected vaccines made in non-SPF eggs were used initially. Then, when the Arthur Webster Pty Ltd company decided to produce commercial V4 vaccine in SPF eggs their early experimental batches were used. Websters went on to produce both conventional and heat-resistant V4 vaccines.

Professor Aini Ideris also explored some of the extension techniques that would be required to convince villagers of the advantages of vaccination. She arranged field days at the university where farmers (often women) could distribute food vaccine to chickens. She organised meetings with senior women who operated as a type of village council.

ACIAR conducted a workshop in Malaysia to present the results of these studies (Copland 1987). Delegates attended from other Asian countries and from Africa. Other Asian countries were invited to join in an expanded research program. Claims for general efficacy of the vaccine approach would be validated if the research findings could be duplicated in further countries.

Other projects in Asia

After the first workshop, ACIAR decided to continue the project in Malaysia and Australia, and to expand it to involve Indonesia, Philippines, Sri Lanka and Thailand. An Australian support team was recruited. This included poultry production experts, pathologists, economists and epidemiologists.

Successful vaccine trials were reported from each country. It became apparent that, where chickens could readily be caught, eye-drop vaccination was preferable to food vaccination. Some considered that provision of housing would be part of the price of access to vaccine. I still see this as a choice for local farmers and veterinary authorities. Oral vaccination will become increasingly important in all species and I encourage further research on food carriers for ND vaccines.

ACIAR conducted a further international workshop in Malaysia. The published proceedings indicated to a wide audience that ND could be controlled in village chickens (Spradbrow 1992).

Other aspects of the project were developed. It was found that village mortality data and epidemiological findings gave protection rates for field vaccination similar to those obtained by artificial challenge. This was expensive work and it will probably not be repeated, but it validates data obtained by simpler methods (Johnston et al. 1992). Computer modelling indicated that virulent strains of ND virus could persist in relatively small groups of breeding chickens of mixed age. This accords with field observations. The standing flock may be as small as 500 chickens. Many villages would support this number of chickens in direct or indirect contact. In epidemiological terms these would constitute a single flock. We anticipate, and indeed we see, two different epidemiologies in village flocks. Some flocks will be free of virus and totally susceptible. These may be completely destroyed on introduction of a single infected bird and result in the epidemics of ND that are so spectacular. Other partially immune flocks with endemic infection will allow virus to persist by spread in the non-immune or partially immune members of the flock. The resulting sparse mortalities will rarely be presented for diagnosis.

ACIAR and other agencies have supported the production and use of I-2 vaccine in further Asian countries. The Food and Agriculture Organization of the United Nations (FAO) funded the initial studies in Myanmar and ACIAR has encouraged the use of the vaccine in many areas of the country. The United Nations High Commission for Refugees fosters use of the vaccine in a remote refugee area of Myanmar on the border with Bangladesh. AusAID supported a successful project in Bhutan. Vietnam was a special case. A small ACIAR project allowed the production and laboratory testing of I-2 vaccine. This was successful, and my Vietnamese colleagues told me they would conduct field trials without further financial assistance. The vaccine is now registered and a national laboratory (NAVETCO) produces some 14 million doses of I-2 each year (Tu 2001). Some is exported to Cambodia and the Lao Republic. I-2 master seed has also been sent to Iran, and successful laboratory tests have been reported from China.

Several other Asian countries are attempting to control ND in village chickens but they are using conventional heat-labile vaccines. It is of interest that the complex village-chicken project in Bangladesh, often referred to as the Bangladesh model, seems to have developed from an initial enterprise focused on the control of ND.

Projects in Africa

ND has also been an enduring problem in village flocks in Africa. Local scientists had learnt of the new heat-resistant vaccines from the ACIAR workshops in Asia and FAO workshops in Africa. Subsequent vaccination studies in Africa have not been coordinated and I may not be aware of all of them. Both V4 and I-2 master seeds have been produced at PANVAC in Ethiopia. Further distributions from this source are not well documented. I-2 or V4 master seeds have gone from Australia to countries including South Africa, Uganda, Nigeria, Zimbabwe, Ghana, Mozambique and Senegal. Mauritius produced its own master seed from V4 virus obtained from a virus repository in the USA. V4 vaccine from Malaysia has been used in The Gambia. Commercial V4 vaccine has been used in west Africa.

Studies that resulted in formal publications are easier to trace. A team led by Dr Robyn Alders has reported effective trials from ACIAR projects in both Zambia (Alders et al. 1994) and Mozambique. Tanzanian workers have tested both V4 and I-2 vaccines in the laboratory and in the field. Dr Ann Foster's team tested V4 vaccine in villages near Dodoma in Tanzania on an ACIAR project (Foster et al. 1999). She showed that villagers and non-government organisations, without formal input from government or universities, could conduct successful trials. The SANDCP might not have proceeded without the examples from these three countries.

The SANDCP resulted from a planning workshop from which a proceedings (Alders and Spradbrow 2001) was published and the deliberations of an AusAID project planning and design team. All the countries of the Southern African Development Community (SADC) were invited to the workshop that was held in Maputo, Mozambique. The design team visited many of the SADC countries and most countries sent delegates to a final workshop held in Johannesburg, South Africa.

Networks and training

Developing new vaccines and demonstrating their efficacy under both laboratory and field conditions have been only parts of the project. The eventual aim had to be local production of vaccine and sustainable delivery to village flocks. Complex activities were required to facilitate these outcomes.

Dissemination of results as they were obtained was essential. Many pivotal studies on village poultry production have been recorded only in reports to donors and these reports reach a limited audience. International meetings and workshops such as those sponsored by ACIAR have been very helpful. Edited proceedings leave a permanent mark. Only some of the useful research in our area is recorded in international scientific journals. There are various reasons for this, including the vagaries of editorial policies and the lack of confidence of many young research workers in developing countries. International projects often offer these workers their first encounter with adequate research funding and external scientific guidance. Electronic publishing is overcoming some of these problems.

It is important that we try to publish our results—our failures as well as our successes. Admittedly it is very hard to ease 'negative' results past editors but it can be done. I recall Dr Alan Jackson, a member of our early support group, insisting at a meeting that experiments do not fail: experiments that do not yield the anticipated results always teach us something. A common factor in some experiments with oral vaccine that failed to induce immunity was that the chickens were kept on wire. We now ensure that chickens vaccinated in this way have contact with vaccine virus excreted in the faeces.

Scattered groups of scientists with common interests have been termed 'invisible colleges'. The sources of information mentioned above have helped bind these groups. The internet now allows us to formalise these groups and to share information. The International Network for Family Poultry Development (formerly the African Network for Rural Poultry Development) has been very beneficial. Its website and electronic newsletter are recommended. A website that arose from the ACIAR project is now operated by the KYEEMA Foundation.

Practical workshops concerned with vaccine production and vaccination have been required to transfer skills. Six short training workshops sponsored by ACIAR and other agencies have been held in developing countries. These were in Pretoria (for 16 African countries), in Dar es Salaam (for Tanzania and Mozambique), and in Ghana, Myanmar, Bhutan and Cambodia. Delegates have attended either a short (usually 2 days) administrative workshop or a longer practical laboratory workshop. Dr Robyn Alders and I have taught the administrative workshops. Topics have included

ND, ND vaccines and extension activities. Ms Sally Grimes has conducted the practical workshops, concentrating on vaccine production and testing, and serological tests. Intensive laboratory courses, up to 3 months long, were conducted at the John Francis Virology Laboratory and funded by various international agencies.

Recent basic studies on I-2 virus

At the John Francis Virology Laboratory I have encouraged further studies on I-2 and V4 viruses shortly before and since my retirement. Two students, Dr Philemon Wambura from Tanzania and Dr Majid Bouzari from Iran, have devoted PhD studies to these viruses. Trainees from overseas have been hosted at the laboratory for training on the production and testing of I-2 vaccine. Ms Sally Grimes coordinated the training and experiments designed to produce additional data on I-2 vaccine. Below are brief summaries of some of these experiments. They have not yet been formally published and the results may be useful to authorities contemplating the introduction of I-2 vaccine.

Dr Bouzari (Bouzari 1996) investigated the early events after oral administration of V4 vaccine. The upper part of the digestive tract seemed to be the site of initial attachment of virus when fed to chickens. Occasional isolation of V4 virus from blood indicated a low level of viraemia. This possibly deposited virus in the middle and lower portions of the intestine, from where it was shed. Viral antigen was detected in epithelial cells and in cells that resembled lymphocytes or macrophages in the *lamina propria*. Studies with organ cultures were only partially successful because rapid autolysis of epithelial cells precluded detection of antigen. However, viral antigen was detected in other cells in the *lamina propria*. The author suggested that prospective oral vaccines should be designed to deliver virus to the cells of the upper digestive tract, or to protect the virus from these receptive cells and the acidity and proteases of the digestive organs targeting the lower digestive tract.

Dr Wambura (Wambura 2003) worked mainly with I-2 virus. This virus is usually titrated in embryonated eggs, and repetitive titrations are very expensive. The author found that I-2 virus produced cytopathic changes in chick embryo kidney cells grown in microtitre trays. End points could be read easily if the cultures were fixed and stained. Exper-

iments requiring numerous titrations of I-2 virus could now be undertaken in laboratories able to produce cell cultures.

I-2 vaccine is sometimes produced in liquid rather than in freeze-dried form and must be used before formal quality-assurance tests can be completed. Dr Wambura determined the minimum amount of I-2 virus that needed to be inoculated into an embryonated egg to produce detectable haemagglutinin after incubation for 11 hours. This test could be refined to give an indication overnight of the potency of a liquid vaccine.

Dr Wambura visited again the problem of delivering I-2 vaccine on food to village chickens. Raw white rice is a readily available substrate but is rapidly lethal to the virus. Cooked white rice is a good vehicle but has a short storage life. However, I-2 virus was readily recovered from raw white rice that had been coated with vegetable oil. Experiments in chickens should be undertaken.

In further experiments, Dr Wambura made 20 serial passages of I-2 virus in embryonated eggs. No heat selection was applied. Thermostability was retained for five passages but declined after that. I-2 vaccine is produced from master seed after only two egg passages. Apparently, further passages could be undertaken without affecting vaccine quality but greatly increasing the amount of vaccine that could be derived from a limited quantity of master seed.

Both I-2 and V4 viruses were used to vaccinate chickens. During the following week, a reverse transcription polymerase chain reaction was used to detect viral genomes in various tissues. Both viruses were detected in samples from both the respiratory tract and the digestive tract. Strain V4 was detected earlier than I-2 in the digestive tract and persisted there for longer. Strain I-2 was detected earlier in the respiratory tract and persisted longer. These data indicate a difference in tissue tropism between the two viruses, with I-2 having greater affinity for the respiratory tract.

Ms Grimes (Grimes 2002) produced a consolidated report on some of the results achieved by the combined efforts of trainees and staff. The observations were drawn from the appendixes of previous reports to ACIAR. A safety trial to World Organisation for Animal Health (OIE) specifications was conducted in SPF chickens. Three groups, each of 10 chickens one day of age, were used. Chickens in the groups received by eye-drop either 10 times the standard dose of vaccine, 100 times the standard dose

of vaccine or phosphate-buffered saline as a control. All chickens remained clinically normal during an observation period of 21 days. This batch of I-2 virus exceeded the safety standard recommended by OIE.

Because of increasing requests for I-2 master seed, current stocks were considered insufficient. A subsidiary master seed was produced in SPF eggs.

Liquid I-2 vaccine was produced and used to conduct a dose–response experiment in chickens with access to a run. Five groups of 12 or 13 5-week-old layer chickens were used. The groups received, respectively, no vaccine, 1/10th the normal dose of vaccine, the normal dose, 10 times this dose or 100 times this dose. Antibody responses were monitored over 18 weeks. There was a limited antibody response to the 1/10th dose, with some birds producing protective levels of antibody at some observations. Chickens in the other vaccinated groups developed protective levels of antibody after 2 weeks and these persisted for the duration of the experiment, but with little indication of dose responsiveness. V4 has given similar results in vaccinated chickens kept on the floor. Of particular note was the finding that chickens receiving 100 times the recommended dose of I-2 vaccine developed no clinical signs.

A similar study was undertaken in layer chickens held individually in cages. Each group contained 11 chickens, and the cages for each group were maintained in a separate room. The serological responses were similar to those in chickens kept on the floor. Groups receiving 1, 10 and 100 doses of vaccine developed protective levels of antibody within 2 weeks of vaccination with no evidence of dose responsiveness. The response to a 1/10th dose of vaccine was poor. V4 vaccine under similar conditions has given a higher antibody response in the groups of chickens receiving higher doses of vaccine, indicating a failure of V4 virus to spread between individually caged chickens. I-2 virus may have a greater ability to spread by the respiratory tract.

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Improving village chicken production by employing effective gender-sensitive methodologies

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Abstract

This paper analyses gender issues faced over a period of 3 years during the implementation of Newcastle disease (ND) vaccination campaigns in Tanzania and Mozambique in the context of the Southern Africa Newcastle Disease Control Project (SANDCP). Aspects related to training, collection of baseline data, monitoring and evaluation, as well as the impact of ND vaccination programs on men and women of different social groups, are dealt with. The paper examines recommendations developed within SANDCP to overcome barriers to women's involvement.

Background

In many parts of Mozambique and Tanzania, the majority of the population is rural-based and involved in agricultural production. Up to one-third of rural households are headed by women, and most of the smallholder sector production is done by women. Female farmers work longer hours than male farmers but have fewer assets, lower income and almost no access to credit and technical support. Raising village chickens plays a vital role in many poor rural households (Alexander et al. 2004). They are generally owned and managed by women and children and are often essential elements of female-headed households. Chickens provide scarce animal protein in the form of meat and eggs and can be sold or bartered to meet essential family needs such as medicine, clothes and school fees. They are often required for special festivals and are essential for

many traditional ceremonies. Chickens can also play an important role in providing households with people living with HIV/AIDS with additional resources.

One of the major constraints to production of village chickens is Newcastle disease (ND) (Alexander et al. 2004), which can result in mortalities of up to 100% (Buza and Mwachhehe 2001).

Tanzania, together with Malawi and Mozambique, has been involved with the Southern Africa Newcastle Disease Control Project (SANDCP), which promotes the local production, quality control of the I-2 thermotolerant ND vaccine, its administration by community vaccinators and the establishment of effective cost-recovery mechanisms.

While the development of thermostable ND vaccines has made it possible to get viable vaccine into rural areas, the vaccines themselves have not been sufficient to guarantee access to vaccine to women and to the poorest households. Agricultural extension services frequently deal mostly with well-off farmers and with main crop and ruminant production. The extension staff are usually male, who mostly contact male farmers and are often not

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trained to assist women and poor farmers. Extensionists are not fully aware that women have different needs and perspectives about chicken raising and that they need to be listened to within a same-sex group. Village leaders are also often mainly male who take decisions about the whole community. Consequently, efforts to ensure that women participate in all phases of the process were an important objective integrated into all activities of SANDCP.

Gender-sensitive methodologies and gender awareness were included in the different activities:

- training of trainers, and of extension staff and vaccinators
- introduction of the activity in villages with participatory rural appraisal (PRA) exercises and selection of vaccinators
- baseline survey and subsequent application of a questionnaire for evaluation of the impact of ND vaccination campaigns
- PRA for evaluation of the impact of ND vaccination campaigns
- an ongoing monitoring system.

By involving men and women farmers in all stages of the process of planning, implementation and monitoring of the vaccination campaigns it was expected that SANDCP would provide them with access to extension messages, improve their capacity to assume a role as community leaders and allow them to increase the benefits resulting from their poultry activity. Both practical and strategic gender needs should be met.

Eight campaigns were carried out in Tanzania and one fewer in Mozambique (one campaign was not performed in the project area in 2004). In all areas, the vaccination campaigns were implemented with the changes in process that this implied in terms of planning and organisation, both for the villages and for the veterinary and extension services. Changes in practices, attitudes and knowledge were recorded for the vaccinators, extension workers, veterinary staff and villagers.

Project evaluation techniques such as individual questionnaires, focus groups, participatory observations and participatory exercises were used to collect more qualitative data, analyse processes and verify the quantitative data gathered through the monitoring system. This evaluation allowed the various impacts of the project on livelihoods to be assessed and differences between stakeholders in livelihood impacts to be established.

To ensure gender awareness and develop a strategy that was designed to take into account people's perceptions, the stakeholders at all levels of the projects were involved in evaluating the impact of the project on men and women. Charts recording the changes during the project life as registered by progress from the baseline data towards project goals using gender-based criteria were elaborated and discussed in same-sex groups and then shared with men and women.

In the monitoring and evaluation system the following aspects were addressed:

- access to resources and project activities
- capacity building
- participation in decision-making
- control over resources and project activities
- gender strategic needs/empowerment.

Data and interviews with people in all areas showed that vaccination campaigns are well-accepted and have had a positive impact on the number of birds. In the project area, women represent around 50% of the vaccinators. Male and female farmers registered an increase in consumption and sale of chickens and eggs. Consumption seems to be more difficult to improve than sales, due to the habit of keeping chickens as a bank for emergency situations. Women and female-headed households are well-represented among the farmers vaccinating and they consider that the increase in sales is benefiting them as they can use the money in quite an independent way according the gender division of resources and roles in rural areas.

This paper analyses gender-sensitive methodologies used for the application of questionnaires and PRA exercises conducted in one village in each of the three pilot areas: Njangwa in Mtwara district and Vikonje in Dodoma district in Tanzania, and Chirodze Ponte in Cahora Basso district in Mozambique. It allows one to see the evolution of the farmers' circumstances following the implementation of vaccination campaigns in the 15 pilot villages identified in Tanzania and Mozambique for the SANDCP monitoring and evaluation process.

Baseline survey and subsequent application of questionnaires

One baseline and two repeat surveys of randomly selected members of the SANDCP target group in Tanzania were implemented in April–May 2003, February 2004 and February 2005 to analyse the

impact of SANDCP. The objective of the study was to identify significant changes that occurred in the target population as a result of the project intervention and to assess the differential degree of change occurring according to gender and vaccinating and non-vaccinating households.

The survey was designed by SANDCP in collaboration with government partners, and adapted to the reality of each country. It contained a variety of questions related to ownership, control, benefits of poultry-raising activities and participation in vaccination campaigns. Data were collected by local government staff in each location, with supervision from SANDCP. Data were entered and analysed by SANDCP. For each year, the sample comprised 100 households selected using systematic random sampling from each of the five target villages in Mtwara and Dodoma districts (Tanzania) and in Cahora Basso district (Mozambique).

In addition to questions on gender-related issues, the survey was designed to assess differences between male and female farmers. Prior to the application of questionnaires, supervisors and extension agents were trained in their use and the importance of ensuring that half the respondents were female was stressed. However, the interviewers did not understand the importance of interviewing female farmers and this was a constraint during the first application. Some examples given later illustrate this situation.

The lack of female interviewers was a big constraint that might have created some difficulties in interviewing women. In Dodoma, 3 of 13 interviewers registered were female. In Mtwara and Cahora Basso no women were registered as interviewers. The percentage of female extension workers is still low in the three countries and it would have been necessary to engage women from outside extension services in order to have 50% female interviewers. It is known that the inclusion of women in teams or projects does not automatically result in a gender-sensitive agenda, but it provides role models and might facilitate access to and empathy with female interviewees.

In Mozambique in 2003, one male interviewer was found applying the questionnaire to men or women indifferently without respecting the instruction given and, at the end, lying about the sex of the interviewee. The interviewer was removed from the team and the other members received an explanation on the importance of gender and the need to respect

the sampling methodology. However, how can we expect an extension worker to understand that men and women have different needs, access to resources, knowledge and attitude to chicken-raising activity if nothing in their training, daily activities or reporting system highlights this difference? The application of the questionnaire can remain for them a kind of academic exercise with little impact on their understanding of reality and gender dynamics if there is no constant analysis and discussion of the importance of assessing male and female opinion, practice, knowledge and attitude.

In the same vein, when the questionnaires were applied for the first time in 2003 in Tanzania by the local team, only 30% of the people interviewed were women. People involved in the first application argued that it was impossible to interview more women because they were not at home or because it is impossible for a man to contact a woman in the presence of her husband. Even within the SANDCP team, the aim of requiring 50% female respondents was hotly debated since some members believed that it was too difficult to reach women and that ultimately it would not have made any difference. A strong and firm request to comply with the established target of 50% of female farmers was made. No special ways to approach women and to seek agreement from their partners to be interviewed by a man were developed, as interviewers considered it was not a problem. Then what was the problem? I strongly believe that it was mainly an attitudinal problem; in the past, people were not requested to take women's perspectives into account, so the interviewers simply went ahead reproducing what they had done previously.

The situation shows some of the difficulties in ensuring that half of the respondents were female. Rigorous training prior to application of questionnaires, as well as supervision during application, were necessary to ensure that targets established for the sample were respected by interviewers. Constant reinforcement of the aim of the exercise and the need to capture the female situation was necessary to ensure the established sample was achieved.

Different impact of vaccination campaigns for men and women?

As well as increasing the understanding of the problems related to vaccination activities, the annual PRA exercises aimed to develop an understanding

of the perceived impact of activities on men and on women and on the different social groups. This was done mainly by having focus group discussions with same sex groups and using PRA tools such as the poultry-raising activity calendar and ranking exercises to identify the evolution of problems related to poultry-raising activity.

The first change registered was that, after vaccination campaigns, chickens did not die of ND. Many quotes from male and female farmers illustrate this situation in the three villages where PRA was conducted. Predators and other diseases are now the first concern.

With the control of ND, flock size increased and the first result was an increase in sales. In some villages, the number of traders increased 'as they know that there are chickens available all the time' (Woman, Njengwa village, Mtwara district, Tanzania, 2005). The price of chickens is high all year round because farmers sell only when they want to, rather than because of the fear of disease.

People still tend to prioritise sale ahead of consumption just as before vaccination, but the level of consumption of chicken and eggs has increased. Households can eat when they want and, instead of eating before and during ND outbreaks, to control the flock size, they tend to eat more when there are a lot of chickens. The whole household benefits from this increased consumption of protein.

The possibility of scaling up animal-raising activities by buying goats with the sale of chickens was

one of the dreams and an indicator of success of ND control identified during the baseline survey in 2003 in Chirodze Ponte. This dream was realised by some farmers in both Chirodze Ponte and Dodoma.

Although farmers want to minimise risks by diversifying their animal-raising activity, it is possible to observe that, due to vaccination campaigns, the value of chicken raising has increased in relation to other activities. As the risk of keeping chickens and managing a big flock decreases, poultry raising becomes more attractive. This point of view is well expressed in the quote below.

'Chicken is even better than goats. Because with five chickens (TSh3,000 each) you get the same amount as selling one goat (Tsh15,000) but to raise a goat that is worth Tsh15,000 it takes more time than to raise five chickens. The price of chickens is even better than a goat. When you keep chickens you get more money than with a goat.'
(Man, Njengwa village, Mtwara district, Tanzania, February 2005)

This observation is extremely interesting as men often despise chickens and prefer other kinds of animals such as goats and cattle. However, as I will explain, ownership of animals and their importance in production systems vary greatly. It is certainly because of this that impact also varies greatly between men and women. However, an increase in the role and value given to poultry raising tends to increase the importance of the people caring for them.

Decision-making process, ownership, control of money resulting from the sale of chickens, and its use

In livestock keeping, each species plays a specific role and is often owned and cared for by a different person in the household. While women own chickens and ducks, men are more likely to own goats and cattle. This implies, therefore, that women tend to have fewer sources of income or exchange than men do. However, the type and range of animals owned by different households and by men and women within the households also vary according to their level of poverty.

Cultural traditions include a fairly formal structure for the different roles of men and women within the household and in all aspects of political

'...if we compare with other villages [where vaccination takes place] it is possible to see the change that was brought by the vaccine because people complain about Newcastle disease and chickens are dying'. Vikonje village, Dodoma, Tanzania, 2005

'We used to eat eggs only rarely; now we can prepare even up to three eggs at the same time and all the family can eat. Before it was only children who were given priority. Now everybody can eat eggs.'

(Woman, Vikonje vaccinating farmers, February 2005)

The first priority is to sell. '70% for sale and 30% for consumption' said one man.

(Njengwa village, Mtwara district, Tanzania, 2005)

'People still eat chickens mainly for festivals; however, consumption of chickens is possible all year round and consumption increased.'

(Woman, Njengwa village, Mtwara district, Tanzania, 2005)

and economic life. Women are under serious time constraints resulting from the many activities that they have to perform (child-bearing/rearing responsibilities, domestic tasks, subsistence/home production, and provision and maintenance of scarce resources of collective consumption, such as water, health care and education).

The differences between the circumstances of male and female farmers often lead them to have different and sometimes conflicting needs or interest in terms of crops or animals preferred. Such a situation has implications for investigation and extension, and must be taken into consideration.

It is commonly accepted that chicken raising is mainly a female activity and that women usually own chickens. It was also reported that chickens can belong to different persons in the family. Very young children can be given chickens to raise to see if they have luck in this activity and to start learning about poultry husbandry (Vikonji village, Dodoma urban district).

Decision-making related to chicken-raising activities varies widely according to women's and men's access to other resources, their level of education, social class and wealth, age, religion, and cultural and socioeconomic factors. Several studies have shown that chicken husbandry is mainly the responsibility of women and children (Mata et al. 2000; Bagnol 2001). Some researchers consider that where chicken business is unprofitable it is more likely to be under the control of women but when it becomes more profitable men become very involved in keeping chickens (Buza and Mwamhehe 2001). The control over the consumption and sale of the animals differs widely according to who is the owner and the availability of other sources of income for men. Usually, if men have larger animals such as goats and cattle under their care and control, or other sources of income, they leave the women with the authority to oversee the raising of chickens and to take decisions in that regard, as this is an activity of lesser social prestige and commercial value. This is especially the case in the south of Mozambique where most of the men find an opportunity to earn an income working in South Africa or in Maputo, and where cattle constitute an important resource providing status and allowing the ploughing of the fields. In the north of the country, access to paid employment is more difficult because, due to mismanagement and lack of capital or as a result of the war, most industries closed down after independence. Due to the prevalence of tsetse flies, cattle are also very scarce, and agriculture,

small livestock and informal business are the main household resources. In Tanzania, the situations in Dodoma and Mtwara districts vary greatly, with more alternatives for men in Dodoma than in Mtwara. Other factors such as sociocultural attitudes and group and class-based obligations also influence men and women's roles, responsibilities and decision-making functions. Moreover, religious or cultural beliefs and practices limit women's mobility, social contact, access to resources, and the types of activities they can pursue. Institutional arrangements can also create and reinforce gender-based constraints or, conversely, foster an environment in which gender disparities can be reduced. All these factors affect women's chances to participate in decision-making related to ND control and to engage in vaccination activities. Access to information is also crucial. For example, in Dodoma in 2003, while the women's group had never heard of ND vaccine, the men's group had. This situation shows that women can be, and often are, less exposed to extension messages even when related to activities that they are in charge of, as in the case of poultry raising.

According to the men in Vikonje (Dodoma district, Tanzania), the decision to slaughter a chicken is made by them, while the women tend to consider that it is a decision shared with their husband and the owner of the bird. This difference between men's and women's opinions reflects the tendency of women to consider that decision-making is shared, while men, because of their role and status, tend to consider that they are the ones who make most of the decisions.

According to women, chickens can belong to different people in the household, including children. The decision to sell the chicken is made by the father and the mother but also by the owner. Once again, showing a different perspective, the men's group tended to consider that they decide on the sale of the birds. The cash realised from chicken sales is used as petty cash, for milling, to buy food, clothes and school uniform, and to pay for medical treatments.

In Dodoma district, women make most of the decisions about the household chicken production enterprise, such as selling them from their home or in the local market, and they use the money for a wide range of household needs. As they usually have money from the sale of the main crop they can decide to vaccinate their chickens. They can usually slaughter a chicken for a guest or home consumption. This situation can, of course, vary from family

to family and from group to group according to specific traditions and habits.

In Chirodze Ponte, in Cahora Basso district (Mozambique), women complained that their husbands were not willing to keep money from the sale of chickens for the next vaccination and wanted to spend it drinking. The discussion around this issue showed that women manage to have some degree of control of the money resulting from the sale of chickens.

In Mtwara district, Tanzania, it seems that decisions in relation to chicken vaccination are taken by both men and women, but women do not have access to money to pay for vaccinations without consulting the male partner. Only female heads of households can make a decision about vaccination on their own. Discussions held with a group of men and women vaccinating in 2005 (Njengwa village, Mtwara district) emphasised the fact that the result of the sale of chickens was very much under women's control. It seems from the discussion that men understand that chickens are for women. Women still present the money earned from chicken sales to their husbands but it is difficult for men to take it and use it as they want. It is in this sense easier for a woman to buy kitchen utensils with chicken money than with money from cashews. As one woman put it: 'It is easier for a man to listen to woman when the money comes from chickens because the decision-making is with women and they can buy a lot of plastic ware'. Income from cashews is seen as male income and is used mainly for house construction. Chickens are seen as a way to improve the quality and quantity of food and kitchen equipment. The money resulting from the sale of chickens is also used to pay school fees.

Discussions showed that increases in women's income resulting from poultry raising, and the increase in self-esteem or status due to their increased capacity and knowledge, were not threatening for men. On the contrary, men and women interviewed explained that, due to the contribution made to the household income, husbands and partners respected their wives more.

By taking into account male and female farmers' needs, SANDCP aimed at improving the household nutritional and economic situation as a whole and allowing women to improve their circumstances by achieving more recognition and benefit from poultry raising. SANDCP aimed to make people aware of the crucial role women play in poultry raising and to

encourage the community and the household to give them more credit for that, more access to technical information and more benefit from their activity. The project aimed at raising the awareness of men and women of the need to increase poultry production to improve the nutrition of women and children in particular.

Reasons for non-participation in vaccination campaigns

In 2005 we held a focus group discussion with 16 women in Chirodze Ponte who were not vaccinating. The objective was to try to understand why they were not doing so. Most of them had no chickens at the time because they had lost all of them to ND. Some had vaccinated once or even twice since March 2003 but none of them had done the full set of three vaccinations per year.

None of them knew that it was necessary to vaccinate three times a year and, even if some knew the vaccinator, they did not know in which month the vaccination would be carried out. They heard from friends that vaccination was helping to save chickens' lives, but women without birds were all in a situation in which they could not afford to buy or borrow a chicken (returning some of the chicks after birth). One of the women vaccinated her chickens in July 2003, after which her flock grew to 50. She vaccinated again in July 2004, but in November she lost 40 chickens. Now she has eight chickens of which five are adult birds. In November 2004 she did not vaccinate. She does not know how many times she is supposed to vaccinate.

This situation showed that the less well-off are sometimes not able to get even one bird to start raising as they do not have a good social network. They tend also to be less informed about the vaccination calendar.

In February 2005, an old lady living with a young nephew in Tete, Chirodze Ponte, explained that she had not enough strength to go into the field or even to pound her maize. She explained that she was unable to build a chicken house as there was no man at home. She had no money to buy a chicken to start raising them again. She had no close family in the village whom she could ask to lend her a bird.

A focus group discussion was also held with non-vaccinating men. Although some knew about ND

control, the reasons for not vaccinating were also related to lack of knowledge of the importance of vaccination and the times when it should be performed.

In Mtwara, there was no obvious, single reason for not vaccinating but a multiplicity of contributing interlinked factors.

'The vaccinator has their own people on their list. Once they passed by my house and they said they needed the money straight away. I did not have the money. They never came again.'
(Woman who never vaccinated, Mtwara, Njengwa village, February 2005)

- Even if they know the vaccinators and know that a vaccination campaign is being carried out successfully they do not know how much it costs, when the vaccinations are held or how many times a year.
- Some are still not very confident of the positive impact of vaccination.
- They have no money at the time of vaccination and do not understand why there is no credit at a time when there is credit available to obtain the sulfate fertiliser for cashews.

In Dodoma, reasons for not vaccinating were more closely related to the bad experience during the first vaccination campaign, which started too late, when ND was already killing chickens. Insufficient explanation about what occurred led some farmers to fear the vaccination campaigns.

Later, due to the success of vaccination campaigns, many farmers lent a chicken to others to start vaccinating and resume raising chickens again, often after several losing their flock as a result of ND.

Women as vaccinators

Only a small amount of gender-specific information, such as the sex of the vaccinator and the sex of the person who owns the chickens, is collected by projects involved in ND control. These data provide information on the benefits from resources (i.e. who benefits from the vaccination and from training activities) and, to a limited extent, on the empowerment of women (i.e. the number of women vaccinators can be seen as aiming to achieve greater equality and change existing roles, thereby challenging women's subordinate position). However, even if there is a general awareness of gender issues among

the staff involved in ND control activities, the progress made and the constraints are rarely systematically analysed and the data needed to plan strategically are still lacking.

Women in Tanzania are encouraged to participate in local government committees. However, several constraints hamper women's participation in decision-making. They can be categorised as socialised, situational and structural constraints. Socialised constraints include the socialisation process itself and gender stereotypes that include the undervaluing of women's roles, activity and knowledge, the undervaluing of different gender styles of operation (collaborative, problem solving and empathy) and cultural practices that stop women participating actively. Women face a lack of self-confidence and capacity to participate to maximum effect, as well as lack of access and control over resources for decision-making. There are also limitations on women's participation in decision-making resulting from situational constraints. For instance, because of their multiple tasks and roles, women have less time to involve themselves in public activities. In addition, distances and meeting times are constraints. In the family, they have to face males who do not allow them to participate in public activities. In public activities, which are generally male dominated, they have to face structural constraints related to the organisational structure. The pervading rigid and hierarchical structure might not suit women.

To some extent, capacity building, empowerment, access to project resources and involvement in the decision-making process can be assessed by looking at data related to the participation of women and men as vaccinators. As mentioned earlier, most of the agricultural/veterinary and extension staff in both countries are male and it was completely outside the project's capacity to alter this situation. However, the project had full responsibility for the selection and training of vaccinators.

As the selection of vaccinators was done during community meetings, it was essential to have participants aware of women's roles in poultry raising and the importance of women visiting other women's houses to vaccinate and carry out follow-up activities. Only with extensive sensitisation using PRA exercises and women presenting their work to men and vice versa was it possible to make women's contribution in chicken raising evident. Where such exercises were not carried out, the project had a firm policy to enrol one man and one woman as vaccina-

tors to ensure that 50% of vaccinators who received training, project benefits and the advantages of the increased status and income resulting from the vaccination activities were women. As the data available show, in the project area this target was achieved and women's participation reached the planned target. In 2002, before SANDCP influence, the percentage of female vaccinators in Mozambique was 5.9% (Bagnol et al. 2002). This proportion increased to 27% in 2003–04 (there were 557 male vaccinators and 212 female). The situation in SANDCP areas shows clearly that it is possible to have women involved if the staff maintains a clear stand on this issue and if training facilities and arrangements are adequate to women's needs. It illustrates how project decisions relating to women's involvement can be crucial to fostering their participation.

Difficulties in identifying women with basic reading, writing and counting skills, as well as husbands' refusal to allow their partner to participate in training for vaccinators, are usually the two main reasons given to explain the low rate of female vaccinators.

The relative performances of male and female vaccinators and reasons for drop-out were not analysed, so it was not possible to better identify criteria for vaccinator selection. However, supervisory activities show that performance of male and female vaccinators was good, with a tendency in some areas where they work together for men to control women's vaccination activity. In other cases, the performance of women was outstanding, as it was in Nhambando village (Cahora Basso) a remote and poor village where Zaida Amadeu, a female vaccinator, is working. In July 2004 she vaccinated a 2,019 chickens, used 10 vials of vaccine and earned MZM759,500, which was around US\$30 at that time (Bagnol 2004). Zaida does not read Portuguese and is not able to properly make a register of the data without the help of the extension worker. The vaccinators in Cahora Basso have a flip chart that they use to explain the importance of the vaccine when they do the chicken census. Zaida uses it but she cannot read the text in Portuguese.

The performance of the vaccinators varies a lot. While Zaida Amadeu in Nhambando managed to vaccinate over 2,000 chickens, her colleagues in M'Bungue village vaccinated only an average of 312 each. To give an idea of the money earned by a vaccinator, the price of a chicken varied between

MZM10,000 and MZM50,000 (US\$0.50 and US\$2.00) in this period.

Conclusions

Regular training and inclusion of gender-sensitive perspectives in all phases of project activities is crucial to improve awareness of staff and partners. However, it is not sufficient to ensure implementation and monitoring of gender-related issues. A clear policy also has to be defined and, in each activity, a clear target of male and female beneficiaries should be defined. Constant vigilance through specialised gender-sensitive monitoring is also required.

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Diploma and certificate courses in poultry production and health: an initiative to build human capacity and enhance poultry production in the East Africa region

Uswege M. Minga¹

Abstract

Currently, the contribution of poultry to household incomes and the national economy in the East Africa region is significant but poorly documented. The potential of both commercial and village poultry production as a viable economic enterprise is very high but has not been exploited fully. The full potential of the poultry industry in East Africa can be realised only if appropriate production methods and technologies are used. One of the reasons why the full production potential is not realised is lack of properly trained labour both at farm and extension/advisory levels. Lack of specialised training is the main reason behind that. The same was emphasised during a stakeholders workshop that was held in Arusha, Tanzania in October 2004. The workshop participants were from the East Africa region and Europe. It was realised that there was no institution in the region that offered specialised training in poultry production and health. It was thus agreed that there was a need to mount poultry certificate, diploma and masters courses in the region. It was also agreed that the certificate and diploma courses be offered by open and distance teaching methods and the masters by conventional methods. The Open University of Tanzania had offered to mount the certificate and diploma courses by distance. The Open University of Tanzania has the experience and capacity to mount such courses and is not hampered by distance. The students will potentially be from all the countries in the East Africa region and beyond, without the requirement of being resident in Tanzania where the university is located.

In this paper, the salient features of the certificate and diploma courses are outlined. The courses will be delivered in the form of self-instructional materials, as hard-print study materials and also electronically available online. The practicals, however, will be conducted on-site in established institutions in participating countries, on poultry farms and in businesses.

The certificate and diploma courses will equip graduates with knowledge and skills for all levels of production enterprises. The graduates will be able to efficiently offer services, manage poultry farms and run their own poultry enterprises. The graduates will thus extend and enhance poultry production in the region.

Introduction

Poultry production in East Africa currently makes a significant economic contribution at both household and national levels. However, the contribution is not captured in government economic data. The

potential of poultry production as an economic enterprise is high. Poultry has a high potential for poverty reduction and wealth creation in rural areas, where close to 80% of the people live and where per-capita income is the lowest. The traditional rural poultry sector, although playing an important socioeconomic and nutritional role in rural areas is not doing well. Although it is a low-input type of production, the output is limited. Husbandry is generally poor and

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killer diseases are very prevalent. Commercial poultry production, on the other hand, is capital intensive and is well suited for income supplementation for the salaried workers and also as a full-time business. It is meant to be a high-input/high-output type of enterprise. However, in the East Africa region and indeed in many developing countries this sector is not performing well, and this can be variably attributed to poor husbandry methods, high prices of feeds and high prevalence of killer diseases.

There is thus urgent need for intervention if the full production potential of these two types of poultry raising is to be realised. One of the most cost-effective and sustainable solutions is appropriate technology. Husbandry and disease control technology must be made available to the target population. Experts to impart knowledge and skills to farmers are too few to make any tangible impact on the poultry industry. The majority of the farmers have had no formal training in poultry keeping and use the largely unprofessional, traditional methods and, as a result, productivity is low and mortality due to diseases is high. To date, specialised courses in poultry production and health are not offered by training institutes in the East Africa region, resulting in limited numbers of people skilled in these matters. In many of the livestock training institutes, poultry production is not taught as a specialised course but rather as part of general animal/livestock production and health, and is hence limited in coverage. There is therefore a great need for specialised training in poultry production and health.

There have been earlier efforts by governments in East Africa to train poultry experts. In Tanzania, for example, a certificate course in poultry production was initiated in 1972 in one of the government training institutes but was stopped 4 years later in 1976 because of a change in government policy. Another attempt was made in 1982, when a diploma course in poultry production was mounted in another agricultural training institute. The course lasted for 9 years and stopped in 1991, again due to a change in government policy (Mtambo 2005).

Recently, the need for a diploma/certificate course has been felt by researchers and extensionists working with farmers in the region. In 2003, the Southern Africa Newcastle Disease Control Project (SANDCP), based in Mozambique but operating also in Malawi and Tanzania, identified lack of expertise in poultry production and health as one of the major constraints to village poultry production (Robyn Alders, pers. comm. 2003). Another regional project,

Improving the Health and Productivity of the Rural Chicken in Africa (IHEPRUCA), based in Tanzania and operating also in Kenya, Uganda and Malawi, identified lack of expertise as one of the major constraints affecting poultry production in the region. In August 2004, IHEPRUCA organised an international workshop to assess the regional demand for poultry diploma/certificate courses. The workshop was co-organised by the IHEPRUCA project and the Danish Smallholder Poultry Network. There were diverse participants in the workshop, including a wide range of stakeholders: veterinarians, animal scientists, academics, livestock ministry officials and farmers from Denmark, Kenya, Malawi, Tanzania and Uganda. The workshop participants deliberated on the need for specialised poultry training and concluded that there was indeed an urgent need for specialised training in poultry production and health, not only at diploma and certificate levels but also at MSc level (Mtambo 2005). It was felt that the highest demand would be for diploma/certificate courses. It was also felt that the distance mode of training would suit most of the targeted potential trainees in the region. The Open University of Tanzania offered to mount the diploma/certificate courses. The university has had 10 years of experience in the distance mode of delivery of its courses.

Diploma and certificate courses are meant to lay great emphasis on practical training, which is an advantage compared with degree courses. The Open University of Tanzania, in collaboration with sister institutions in the region, will mount such courses starting in 2006. The courses will be offered by distance-education mode. The advantage of distance education is its convenience. A student does not have to leave their residence but continues with their normal working life and chores while studying. Distance education is not limited by space and is borderless, and hence it is possible to train many students at any one time from anywhere in the region or the world.

Details of the courses

Course objectives

The diploma and certificate courses are meant to train students so that they are equipped with balanced theoretical knowledge as well as practical skills in poultry production and poultry health. The poultry courses will include all domestic poultry,

namely chickens, ducks, guineafowl, turkeys, pigeons, geese and ostriches. The main emphasis, however, will be on chickens. Unlike the conventional courses, both the intensive commercial and the extensive but improved rural/village poultry production systems will be taught.

It is envisaged that, after completing a 2-year diploma or certificate course, the student will be fully competent and qualified to undertake all duties and responsibilities in all types of poultry-production enterprises varying from smallholder, to rural poultry unit, to large-scale commercial units. The diploma course will cover topics in greater depth.

Diploma course graduates

Upon successful completion of the diploma course, the graduates are expected to have the knowledge and skills to be able to:

- plan and set up poultry production enterprises, including large-scale and small-scale commercial production as well as backyard and rural poultry production enterprises
- manage and run all levels and types of poultry production enterprises ranging from simple rural, backyard, smallholder, and small-scale operations up to large-scale poultry enterprises
- plan and set up their own poultry production enterprise/farm
- identify, prevent and treat poultry diseases
- plan, set up and run poultry products marketing systems
- offer extension and marketing services to all levels of commercial and rural poultry farmers and village/community-based poultry workers
- plan, set up and run poultry feed mills and ensure feed quality
- plan, set up and run poultry meat and egg plants
- set up and maintain commercially and consumer acceptable quality standards of poultry products for local and export markets
- offer assistance in training and research on poultry health and production.

Minimum entrance requirements for the diploma course

Entrants to the diploma course must have either one or more passes at principal 'A' level in science subjects and must have passed biology and chemistry at 'O' level, or hold a Certificate in Animal Health or Animal Production from a recognised institution.

Poultry certificate course graduates

Upon successful completion of the certificate course, the graduates are expected to have the knowledge and skills to be able to:

- help to plan and set up poultry production enterprises, including large-scale and small-scale commercial poultry production as well as backyard and rural poultry production enterprises
- help to manage and run all levels and types of poultry production enterprises ranging from simple rural, backyard, smallholder, and small-scale operations up to large-scale poultry enterprises
- plan and set up their own poultry production enterprise/farm
- detect diseases and take appropriate measures to prevent and control them
- offer extension and marketing services to all levels of commercial and rural poultry farmers and village/village-based poultry workers
- help to plan, set up and run poultry feed mills and ensure feed quality
- help to plan, set up and run poultry meat and egg processing plants
- set up and maintain commercially and consumer acceptable quality standards for poultry products for local and export market.

Minimum entrance requirements for the certificate course

Entrants to the certificate course must have five passes at 'O' level or equivalent, and the passes must include biology/agriculture and chemistry.

Mode of study of the diploma and certificate courses

The courses will be offered mainly by the distance mode of delivery. Study materials will be supplied to paid-up students. The study materials will be written in a house style that is suited for distance learners and will be stimulating and thought-provoking for adult as well as young students. Both printed and electronic forms of the study materials will be provided.

Students will be required to attend practical training at designated, established institutions and laboratories, and to undertake field attachment to designated poultry farms and enterprises.

Students will be required to attend face-to-face sessions in order to help them understand the course.

Diploma students will be required to undertake and write-up a specific research project on a selected

topic, the report on this to be submitted as a partial fulfilment of the diploma course at the end of the second year.

Practicals for the diploma and certificate courses

Students will be required to attend supervised practicals for 12 weeks in a year. Students shall do the practicals in approved collaborating institutions and farms in their home countries. The institutes and farms will be those that practise the activities related to the courses learnt that year. Students will be required to write a practical report at the end of the practical/field attachments, indicating duration, activities performed and comments. The report shall

be signed by the local supervisors where the student was doing their practical.

One full day of practicals at a station (institute/farm) shall be equivalent to 6 hours of laboratory practicals. The types of stations for student attachment will be specified in detail in the practical guidelines that will be supplied together with study materials to paid-up students.

Poultry diploma course: course units and hours

Students will be required to complete seven course units equivalent to 410 hours of lectures and 450 hours of practicals and hence a total of 860 hours for the first year or the first part of the course (Table 1).

Table 1. Course titles for diploma course theory and practical in poultry production and management year 1 or part 1

Subject no. and code	Subject	Hours		
		Theory	Practical	Total
1. ODP 001	Introduction to domestic poultry production	30	–	30
2. ODP 002	Avian anatomy	60	60 (i) Poultry research and development institutions	120
3. ODP 003	Avian physiology and biochemistry	90	60 (i) Poultry research and development institutions (ii) Disease diagnostic laboratories and feed analysis laboratories	150
4. ODP 004	Poultry health: microbiology	60	90 (i) Disease diagnostic laboratories (ii) Poultry research and development institutions	150
5. ODP 005	Poultry health: parasitology and entomology	60	90 (i) Disease diagnostic laboratories (ii) Poultry research and development institutions	150
6. ODP 006	Introduction to poultry breeding	60	60 (i) Hatcheries (ii) Rearing farms	120
7. ODP 007 (elective)	Gender and socioeconomic aspects of poultry production, community collaboration and group formation and marketing	50	90 (i) Farms (large scale or small scale, village/ household with local free-range poultry) (ii) Farmer schools (iii) Community-based organisations (livestock and others)	140
	Total	410	450	860

Table 2. Course titles for diploma course theory and practical in poultry production and management year 2 or part 2

Subject no. and code	Subject	Hours		
		Theory	Practical	Total
8. ODP 008	Poultry diseases and biosecurity	60	30 (i) Farms (large scale or small scale, village/ household with local free-range poultry) (ii) Disease diagnostic laboratories and feed analysis laboratories (iii) Poultry research and development institutions	90
9. ODP 009	Poultry pathology and disease diagnosis	40	42 (i) Farms (large scale or small scale, village/ household with local free-range poultry) (ii) Disease diagnostic laboratories and feed analysis laboratories (iii) Poultry research and development institutions	82
10. ODP 010	Management of poultry diseases	40	36 (i) Farms (large scale or small scale, village/ household with local free-range poultry) (ii) Disease diagnostic laboratories and feed analysis laboratories (iii) Poultry research and development institutions	76
11. ODP 011 (elective)	Applied poultry breeding: breeds, ecotypes, local ecotypes and productivity	30	36 (i) Farms (large scale or small scale, village/ household with local free-range poultry) (ii) Rearing farms (iii) Poultry research and development institutions	66
12. ODP 012	Poultry nutrition and feeding	45	48 (i) Farms (large scale or small scale, village/ household with local free-range poultry) (ii) Feed mills (iii) Disease diagnostic laboratories and feed analysis laboratories	93
13. ODP 013	Poultry husbandry: rural and commercial, housing, hygiene	45	36 (i) Farms (large scale or small scale, village/ household with local free-range poultry) (ii) Supermarkets (iii) Restaurants	81
14. ODP 014	Hatchery establishment and management	30	180 (i) Hatcheries (ii) Rearing farms	210
15. ODP 015	Poultry and poultry products; processing and marketing	30	30 (i) Farms (large scale or small scale, village/ household with local free-range poultry) (ii) Poultry processing plants (iii) Supermarkets (iv) Restaurants	60

Table 2. (Cont'd) Course titles for diploma course theory and practical in poultry production and management year 2 or part 2

Subject no. and code	Subject	Hours		
		Theory	Practical	Total
16. ODP 016	Poultry entrepreneurship, farm management finances and record keeping	30	30 (i) Farms (large scale or small scale, village/ household with local free-range poultry) (ii) Poultry processing plants (iii) Farmer schools (iv) Computer laboratories (v) Face-to-face sessions with tutors and fellow students	60
17. ODP 017 (elective)	Extension methodologies, and rural sociology participatory constraints	50	30 (i) Farms (large scale or small scale, village/ household with local free-range poultry) (ii) Face-to-face sessions with tutors and fellow students (iii) Supermarkets (iv) Restaurants (v) Community-based organisations (livestock and others)	80
	Total	400	498	898

Duration of the diploma and certificate courses

Each of the courses will last a minimum of 2 years and a maximum of 4 years.

Fee structure

The fees are highly subsidised for East African and Southern African Development Community nationals: Shs.400,000.00 (US\$395.00) or equivalent per year. For other nationals, the fees are US\$1,268.00 per year. The fees include a Shs.6,000.00 (US\$6.00) annual subscription to the Open University of Tanzania Students Organisation. They do not include direct student costs such as travel, per-diem allowances or living expenses. Fees are subject to review from time to time but any changes will be given one year's notice.

Admission and registration

A candidate will be considered for admission to the diploma course if they meet the minimum entry requirements. Registered students will be only those who have paid the required annual fees. Only registered students will be supplied with study materials and allowed to sit for the required examinations.

One cohort of students must complete the course before new students are admitted. Therefore new students will be admitted every 2 years.

Assessment

Students' understanding and knowledge will be assessed in two, timed tests and one examination per year. In addition, a practical report will be assessed.

Syllabuses of the diploma and certificate courses in poultry production and health

The contents of the poultry diploma and certificate courses were formulated based on the syllabuses that were previously used in government training institutes in Tanzania. They were updated and improved by experts from Sokoine University of Agriculture, SANDCP, the ministry responsible for livestock development in Tanzania and, finally, at a workshop of experts held in Kibaha, Tanzania in June 2005.

The syllabuses were endorsed by the Ministry of Water and Livestock Development and signed-off on by all relevant departments of the Open University of Tanzania.

Each syllabus is divided into course units, each with designated course hours. The number of hours per course unit differs from one course unit to another. For each course unit there will be one item of study material.

For the second part or second year, students will be expected to complete 10 course units equivalent to 400 hours of lectures and 498 hours of practicals and hence a total of 898 hours (Table 2).

Poultry certificate course: course units and hours

Students will be required to complete seven course units equivalent to 360 hours of lectures and 540 hours of practicals and hence a total of 900 hours for the first year or the first part of the course (Table 3). For the second part or second year, students will be expected to complete six course units equivalent to 360 hours of lectures and 498 hours of practicals and hence a total of 898 hours (Table 4).

Launching the program

The diploma and certificate courses will be launched in early 2006 and study materials will be ready for use by then. Study materials will be written by experts from collaborating universities, mainly Sokoine University of Agriculture in Tanzania and the Open University of Tanzania, and by other experts in the field. Additional collaborating experts, institutes and universities will be identified before and after the launching of the program within the region and beyond. The program will be advertised and applications will start being received before the courses start. The studies will commence formally at the end of March 2006.

Table 3. Course titles for certificate course theory and practical in poultry production and health: year 1 or part 1

Subject no. and code	Subject	Hours		
		Theory	Practical	Total
1. OCP 001	Introduction to domestic poultry production	30	–	30
2. OCP 002	Avian anatomy and physiology	60	90 (i) Poultry research and development institute (ii) Disease diagnostic laboratories and feed analysis laboratories	150
3. OCP 003	Introduction to poultry breeding	30	60 (i) Small scale, village/with local poultry (ii) Rearing farms	90
4. OCP 004	Poultry nutrition and feeding	60	90 (i) Farms (large scale or small scale), village/household with local free-range poultry (ii) Disease diagnostic laboratories and feed analysis laboratories (iii) Feed mills	150
5. OCP 005	Poultry management	90	120 (i) Farms (large scale or small scale, village/household with local free-range poultry	210
6. OCP 006	Poultry health: microbiology and parasitology	60	90 (i) Farms (large scale or small scale, village/household with local free-range poultry (ii) Disease diagnostic laboratories and feed analysis laboratories (iii) Poultry research and development institute	150
7. OCP 007	Gender, sociocultural and economic aspects of poultry production	30	90 (i) Farms (large scale or small scale, village/household with local free-range poultry (ii) Farm school (iii) Community-based organisations	120
	Total	360	540	900

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Table 4. Course titles for certificate course theory and practical in poultry production and health: year 2 or part 2

Subject no. and code	Subject	Hours		
		Theory	Practical	Total
8. OCP 008	Poultry diseases and disorders	60	90 (i) Farms (large scale or small scale, village/household with local free-range poultry) (ii) Disease diagnostic laboratories and feed analysis laboratories (iii) Poultry research and development institutions	150
9. OCP 009	Poultry diseases diagnosis and management	80	90 (i) Farms (large scale or small scale, village/household with local free-range poultry) (ii) Disease diagnostic laboratories and feed analysis laboratories (iii) Poultry research and development institutions	170
10. OCP 010	Hatchery management	60	180 (i) Hatcheries	240
11. OCP 011	Poultry and poultry products	60	60 (i) Rearing farms (i) Supermarkets/restaurants (ii) Processing works	120
12. OCP 012	Poultry farm accounting and record keeping	60	60 (i) Rearing farms (ii) Farm schools	120
13. OCP 013	Extension	40	60 (i) Rearing farms (ii) Hatcheries (iii) Supermarkets/restaurants (iv) Farm schools	100
	Total	360	540	900

From a model to a learning approach: the impact of DANIDA-supported smallholder poultry-production projects in Bangladesh

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Abstract

The paper summarises the findings and recommendations for the development of pro-poor smallholder poultry activities, with specific reference to development activities in Bangladesh. Smallholder poultry production is generally perceived to be an important tool for poverty reduction in Bangladesh and capable of reaching poor women. The three projects studied, SLDP-1, PLDP and SLDP-2, included nearly 1 million women beneficiaries and thus reached out to approximately 5–6 million people when the families of these women are included.

The paper evaluates the impact achieved over 12 years of livestock development projects supported by the Danish International Development Agency (DANIDA), as well as the effectiveness of the so-called 'Bangladesh poultry model' and the modalities applied. Findings show that the level of monthly income from poultry among former and present beneficiaries was low (about US\$4 per month), but for the majority of the women it was the only income source. Despite being only a marginal income increase from poultry, this income nevertheless has a positive effect on the livelihood of the beneficiaries. Recent findings confirm the non-sustainability of the interlinked poultry model with its 6–8 interdependent poultry production enterprises (or cadres). Individually, simple activities and enterprises may be profitable but, when external support stops, the largely supply-driven structure falls apart. Results from SLDP-2 show that the so-called model-breeders and mini hatcheries were delivering economic losses to the farmers involved, whereas more simple approaches using local birds as brooders could create an increased income for the farmers involved.

It is argued that introducing simple techniques does not require high initial investments and, as such, less credit than previously anticipated is needed for the initial improvement of smallholder poultry production. Further investigation of the economic benefits of starting poultry activities with and without credit, and with different levels of inputs, such as birds and supplementary feeds, is recommended. According to the findings, the easier and simple method may be adapted to fit local conditions, and there is a higher probability that farmers will use the technology. Participatory training methods, such as are applied in farmer field schools, are suggested as tools to be tested in the context of Bangladesh livestock development.

The Ministry's Department of Livestock Services (DLS) has played a specific role in terms of delivery of vaccines, day-old chickens and training and follow-up for farmers in all three projects. However, recent findings show that DLS is not able to meet all the demands for its services.

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The role of the World's Poultry Science Association in support of family poultry farming in developing countries

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Abstract

The World's Poultry Science Association (WPSA), which has more than 7,000 members across 74 countries, has played an increasingly important role in the promotion and support for family poultry farming in the developing countries of the world. Through the organisation of workshops, symposia, regional conferences and World's Poultry Congresses, WPSA has facilitated information exchange in all aspects of poultry science, technology and production for many years. At these forums over the past 15 years, an increasingly greater emphasis has been given to family poultry farming issues. The International Network on Family Poultry Development is now a global working group of WPSA, and a Working Group on Small-Scale Family Poultry Farming has recently been established within the Asian Pacific Federation of WPSA.

In order to maximise the benefits globally to smallholder poultry farming families, there is a need at this time for a greater degree of collaboration and coordination of the activities of the bodies and agencies supporting family poultry farming in developing countries. It is suggested that a working group be set up with representation from the various bodies and agencies, to establish and maintain communications between them and coordinate their respective activities in support of family poultry farming.

Introduction

The World's Poultry Science Association (WPSA) has over 7,000 members in 74 countries around the world. The objectives of the association are to promote the advancement of knowledge on all aspects of poultry science and the poultry industry worldwide, principally by facilitating exchange of information through the organisation of group

meetings and regional and world congresses. To promote membership of the organisation in developing countries, the cost of belonging to the world association in those branches is only half that of the membership of branches in the developed countries. All members receive copies of the World's Poultry Science Journal, published quarterly and now in its 61st year of publication.

There are currently two federations within WPSA; viz. the Federation of European Branches and the Federation of Asian Pacific Branches. Thirteen working groups have been established over the years within the European federation, covering areas including genetics and breeding, nutrition, meat and egg quality, poultry welfare, physiology, education and information, turkeys and ratites. These working groups have been involved in the organisation of focused workshops, symposia and

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conferences. Recently, the Asian Pacific federation established its first working group on small-scale family poultry farming.

In 1992, the Netherlands branch of WPSA organised the 19th World's Poultry Congress in Amsterdam, and it was here that, for the first time, a World's Poultry Congress program had included, in plenary, symposium and poster sessions, a significant number of papers focused on village/family poultry farming. The increasing awareness of the importance of chickens and other poultry to rural and peri-urban communities in developing countries in their impact on poverty alleviation, income generation and food security, was beginning to be recognised by the mainstream poultry scientific community, if not by certain livestock development agencies. Since then, all World's Poultry Congresses have devoted a significant proportion of their programs to discussion of aspects of family poultry farming in developing countries. In Istanbul at the 22nd World's Poultry Congress in June 2004, the opening session was entitled 'Global challenges and benefits related to poultry R&D in the Third World', signifying the recognised high importance of this area of study.

The International Network on Family Poultry Development

The International Network on Family Poultry Development (INFPD), a global working group of WPSA, is an independent association supported by the Animal Production and Health (AGA) Division of the Food and Agricultural Organization of the United Nations (FAO) and administered by a seven-member executive committee. INFPD is mainly an information exchange network, whose objective is to encourage sustainable high levels of productivity within the family poultry farming subsector and, in so doing, facilitate income generation, alleviate poverty, improve family nutritional standards and contribute meaningfully to food security. The focus of action of the network thus far has been to collect data and detailed information about family poultry production systems in the different regions, with the aim of providing sound information and advice for application by small-scale poultry farmers. Information is disseminated through a trilingual (English, French and Spanish) newsletter that is produced twice a year and distributed electronically, but also

with a printed version for members without email access.

The network, which started as the African Network for Rural Poultry Development (ANRPD), was set up during the international workshop on rural poultry development in Africa, held in November 1989 in Ile-Ife, Nigeria. The name was changed to INFPD at the ANRPD December 1997 general meeting in M'Bour, Senegal. Support for the network continues to be provided by a number of international organisations including FAO, the International Fund for Agriculture Development of the United Nations, the Danish International Development Agency (DANIDA), the Technical Centre for Agricultural and Rural Cooperation, Wageningen, The Netherlands and the International Development Research Centre, Ottawa, Canada. At the 11th European Poultry Conference in Bremen in September 2002, the WPSA executive council approved the establishment of INFPD as a global working group within WPSA. The coordinator of INFPD, Professor Babafunso Sonaiya from Nigeria, is the chairperson of the global working group. Members of the network include researchers, policymakers, educators, staff of development agencies (non-government organisations (NGOs)), aid donors and smallholder farmers. To date, however, only a small number of INFPD members have joined WPSA.

WPSA Asian Pacific Federation Working Group on Family Poultry Farming

The inaugural meeting of the Asian Pacific Federation of WPSA's Working Group on Family Poultry Farming was held at the 4th International Poultry Show and Seminar in Dhaka, Bangladesh, on 11 March 2005. The working group was mooted at the 21st World's Poultry Congress in Montreal in 2000 and was championed by Dr Bruce Sheldon, the senior vice-president of WPSA, until his lamented death in April 2003. Dr Quazi Huque from Bangladesh was elected chair of the working group at the 7th WPSA Asian Pacific Federation Conference at the Gold Coast, Australia, in October 2002, but it was not until shortly before the inaugural meeting in Dhaka that Dr Michael Evans from Australia was elected to the position of secretary of the working group. The purpose behind the establishment of the

working group under the Asian Pacific federation at that time was to give WPSA a direct involvement in this increasingly important area. It would also provide some degree of global balance to the support given to family poultry farming through the INFPD, whose focus up until then had been primarily on the African continent.

Each member country of the Asian Pacific federation is represented on the working group by two delegates, either elected or nominated by the WPSA branch in the country. Goals for the working group, and the actions required to achieve those goals, were developed during the inaugural meeting. To achieve its prime aim of supporting small-scale family poultry farming in the Asian Pacific region, the working group will facilitate the transfer and sharing of information, knowledge and practical experience by organising and securing funding for workshops and meetings, as well as providing suitable literature either directly or through the branches of the Asian Pacific federation. One of the aims of the working group is to establish firm linkages with INFPD, FAO, the Danish Network on Smallholder Poultry Development, the International Rural Poultry Centre of the KYEEMA Foundation, the United Nations Development Programme and other development organisations and agencies.

The next meeting of the working group will likely be held in conjunction with the 2nd South Asian Regional Poultry Conference in Pune, India, in September 2006. For that meeting, the country representatives have been asked to develop a plan that identifies their country's particular needs with respect to family poultry farming. There are tentative plans to hold a workshop on family poultry farming immediately before this in Bhutan. It is hoped that the workshop, which will also serve as the launch of a WPSA branch in Bhutan, will be sponsored by WPSA, FAO and the KYEEMA Foundation.

Activities to assist tsunami victims

WPSA sponsored the attendance of two people each from the WPSA Sri Lankan and Indonesian branches at the Dhaka symposium and working group meeting, with the purpose of discussing with them ways in which WPSA might assist in tsunami relief in the two countries through support for some aspect of poultry production. Reports were presented to the meeting by the representatives from

each country as to the dramatic impact of the tsunami on the people in general and on those engaged in poultry farming in particular. After the meeting, the working group received a focused application from the Sri Lankan branch to assist with reconstruction of small-scale broiler, layer and backyard units across three provinces. The application has been distributed to various WPSA branches and, in Australia, for example, it has been sent along with the branch's endorsement and support to more than 20 NGOs that have received funding for tsunami relief work.

A meeting to discuss tsunami relief requirements was held recently in Bogor, Indonesia, to which the President of the WPSA Asian Pacific Federation was invited. It is likely that proposals similar to that from Sri Lanka will be developed, for which WPSA will again play a role as funding facilitators and as a possible source of technical expertise in the required reconstruction.

The need for collaboration and cooperation between agencies supporting family poultry farming

There are many bodies and agencies involved in the support of family poultry development globally, but the degree of communication between them has been, for the most part, less than optimal. Finite, and in many cases shrinking, funding argues a strong case for greater cooperation and collaboration between the bodies to maximise the benefits to smallholder poultry families. Through the staging of workshops, symposia, conferences, World's Poultry Congresses and federation meetings, FAO, INFPD, WPSA, DANIDA, the Australian Agency for International Development and the Australian Centre for International Agricultural Research have brought many of the players from the various bodies and agencies together in forums for discussion. Nevertheless, there needs to be a greater degree of communication and follow-up to these meetings to achieve a united approach to a global program of work. There would seem to be a need for a greater level of involvement and technical input from poultry scientists in the poultry support programs pursued by the myriad of NGOs, many of them with limited technical backing. Further, a significant number of aid projects has been too narrowly focused with inadequate recognition of the complex production

systems that are inherent in smallholder poultry operations, and of the need for participatory involvement.

It is good to see the broad representation of researchers and facilitators from so many institutions and agencies at this conference. One very desirable outcome from the meeting would be the development, albeit informally at this stage, of a

working group across the major bodies and agencies at least, with an aim to develop and maintain communication and to coordinate the activities of the bodies in question in support of family poultry farming. It would be good to see the present incomplete jigsaw puzzle assembled into a coherent and recognisable picture.

Village chickens in Myanmar: characteristics, constraints and methods for improving health and production

Joerg Henning^{1,*}, Joanne Meers¹, John Morton¹, Bob Pym¹ and Than Hla²

Abstract

A 2-year ACIAR-funded project was initiated to investigate the major constraints to village chicken production in Myanmar and to evaluate methods of improvement. A baseline study was conducted over a 6-month period in 307 randomly selected households in 10 villages throughout the Yangon division. Farmers surveyed had never used any form of Newcastle disease (ND) vaccination in their flocks. Blood samples were collected at monthly intervals and tested for ND antibodies. Two major constraints were identified: mortality in mainly adult birds due to ND and poor survival of chicks up to about 6 weeks of age. Across all study months, the average incidence rate of mortality (deaths per 100 bird-months) was 4 per 100 bird-months for adults, 9 per 100 bird-months for growers and 16 per 100 bird-months for chicks. Pronounced peaks in mortality incidence were observed in some villages, usually associated with climate changes and the seasonal occurrence of ND (determined by clinical symptoms). A high proportion of deaths was attributed to disease amongst adult birds, while predation, exposure to unfavourable environmental conditions and malnutrition were considered to be major causes of mortality among chicks.

The baseline study was followed by a series of intervention studies. The two intervention strategies assessed were vaccination with I-2 ND vaccine and alternative chick rearing management (confinement rearing in combination with supplementary feeding of chicks). Several treatment groups were established, including both partial and total flock ND vaccination, alternative chick rearing management and various combinations of these. By comparing different interventions over 1 year, optimal intervention strategies will be identified and economically evaluated. This will be followed-up by the development of appropriate extension materials to enhance the delivery of our recommendations and to facilitate broad dissemination of information about the health and management of village poultry.

Introduction

In Myanmar, about 80% of the total chicken population of approximately 60 million birds is kept under scavenging conditions in villages. Newcastle disease (ND) has been considered to be a major

cause of mortality in village chickens, but there is limited scientific evidence supporting this. A master seed of the I-2 ND strain was introduced into Myanmar in 1998 as part of a Food and Agriculture Organization of the United Nations (FAO)-sponsored ND control program and a nationwide ND program commenced in 2000. Currently 28 million doses of I-2 vaccine are produced per year, but less than a quarter of the village chicken population is currently vaccinated.

Before the start of this project, no information existed on constraints to village chicken production

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in Myanmar. However, it had been proposed that village chicken production was not achieving full potential because of poor husbandry and a high incidence of ND. This project was developed in 2003 by the Australian Centre of International Agricultural Research (ACIAR) after village chicken production was identified as priority opportunity to improve the welfare of Myanmar people in the rural smallholder sector.

The project was divided into two stages: a baseline study followed by an intervention study.

Baseline study

The objective of the baseline study was to identify the major health and husbandry constraints to village chicken production.

Methods

In the study region (the Yangon division), a sampling frame containing all chicken-owning households in 10 villages with no history of ND vaccination was obtained by field veterinarians. From this sampling frame, 307 households were randomly selected. Questionnaires were developed to collect data on chicken productivity, husbandry, chicken health—including ND, and chicken marketing. These questionnaires were translated into Myanmar and trained field veterinarians obtained information from farmers. Retrospective data were collected for the 1-year period before the start of the study and prospective data were collected by field veterinarians who conducted monthly visits for 6 months. In addition, within each of the 307 flocks, four blood samples were collected monthly from chickens randomly selected by field veterinarians and, using the haemagglutination inhibition test, analysed for antibodies against ND virus.

Results

From the retrospective data, the chicken mortality incidence risk was estimated for different age groups. On average, about a quarter of chicks were reported to have died before reaching 2 months of age. Average estimated 12-month incidence risks in growers and adults prior to the start of study were around 20% and 5%, respectively. Proportional mortality rate estimates are shown in Table 1. Among adult birds, disease was a predominant cause of mortality, while predation was a major cause of mortality in younger birds. Exposure to environmental conditions was also considered to be a major cause of deaths in chicks, while losses reportedly due to theft increased with the age of the birds.

Retrospectively, only 11% of farmers reported ND occurrences in their flocks in the 12 months before the start of the study. Disease outbreaks were generally reported to occur in an annual pattern, but some farmers reported disease occurrences at intervals of 2, 3 or 4 years. Most of these outbreaks happened in the hot season in March and April. In the periods when ND was thought to have occurred, the average estimated mortality risk in affected households was 68% (range 27% to 100%).

Over the 6-month prospective data collection period, the incidence risk for overall mortality was 5–10%, with higher incidence risks in the months of March and April. The average monthly incidence rate of mortality, i.e. deaths per 100 bird-months, was 16 for chicks, 9 for growers and 4 for adults. The proportion of farms with an average ND antibody titre above 2³ was highest in March.

Discussion

The incidence of mortality was highest among chicks. Exposure to extreme weather conditions is believed to be the main cause of death in chicks. It is

Table 1. Proportional (%) mortality rates among different age groups of chickens, based on retrospective data collected in village households in Myanmar in 2004

	Chicks (≤2 months)	Growers (>2 months – 6 months)	Adults (>6 months)
No. of farmers interviewed	40	296	296
Disease	20	61	73
Predation	33	18	2
Theft	0	1	6
Weather exposure	42	17	15
Other/unknown	5	2	5

likely that this exposure, in combination with malnutrition, increased susceptibility of chicks to infectious agents, causing the respiratory and intestinal problems that were often observed. Chicks are also the age group most prone to predation. However, diseased birds may also be more easily preyed on and therefore different causes of mortality were not independent of each other and were difficult to distinguish clearly from each other. However, from these findings, it seems likely that improving husbandry, especially confinement housing of chicks and supportive feeding, would be likely to protect chicks from these major causes of death.

In contrast, growers and adults were more prone to the occurrence of disease, with a high, but greatly varying, mortality. ND outbreaks seemed to be clustered in the hot season. As no vaccination against ND was intentionally conducted in the villages, antibody titres over 2^3 , which are believed to be protective (Spradbrow 1993/94), were considered to be due to exposure to the field virus. However, any observed association between season and ND has to be carefully evaluated, as other factors might confound any relationships between weather and the occurrence of ND.

Intervention study

The objectives of the study were first to assess the effects of ND vaccination on the incidence of clinical ND in individual birds and second to assess effects of improved husbandry on mortality incidence in chicks to about 6 weeks of age.

Methods

This study was set up as a controlled trial and carried out in 160 households with village chickens in their normal environment over a period of 12 months.

The interventions included I-2 vaccination applied at the individual bird level and at flock level, placebo vaccination and changes to the management of chick

rearing, both with and without I-2 vaccination. The management changes included confined rearing of chicks with the hen for 1 week under locally designed bamboo coops. Chicks were also supplied with supplementary chick feed provided in a creep feeder inside the bamboo coops. In weeks 2 and 3, chicks were confined at night with the hen and scavenged during the day. From weeks 4–6, chicks were confined by themselves at night. This management strategy was chosen as it allows a high level of protection of chicks and should result in better nutritional status of chicks during their early growing period.

In addition to the completion of a questionnaire similar to the baseline survey each month, recording forms were distributed to farmers to record the fate of chicks up to 6 weeks of age each week. Blood samples were collected from wing-tagged birds to allow the monitoring of individual bird antibody titres against ND.

Data from July 2004 until July 2005 have now been collated. In a comparison of different intervention treatments over all seasons, the optimal intervention strategy will be identified and economically evaluated. Household-level outcomes to be assessed include chick mortality incidence, total bird numbers and numbers sold at markets, the amount of chicken meat consumed within the household and changes in the awareness of the farmer towards village chicken production.

Based on these outcomes, appropriate extension materials containing recommendations for sustainable and profitable village chicken management and disease prevention strategies will be developed.

Acknowledgment

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Village chicken keeping in Solomon Islands

Russell Parker¹

Abstract

The first inhabitants of the Pacific islands probably brought chickens with them from Asia. At present, poultry production in villages in Solomon Islands is hampered by poor nutrition, housing, breeding and control of disease. The Kai Kokorako Perma-Poultry enterprise seeks to overcome these problems. A training manual has been produced. It urges poultry keepers to supply, each day, separate foods that are sources of energy, protein or protective elements. Specific poultry houses are built from bush materials to simplify feeding and for protection from predators. The current village genotypes seem adequate for the rural industry. Training has been offered in all aspects of poultry production.

Introduction

Pacific islanders have probably known village fowls since their first migration canoes sailed from Asia thousands of years ago. They readily understand the use of a poultry house made from similar materials to their own home, a balanced diet from their gardens and usual protein sources.

More than 80% of the 500,000 population of Solomon Islands live in a rural subsistence lifestyle. Recently, this lifestyle has been placed under enormous pressure as thousands of islanders returned to their home village from the capital, Honiara, during a 3-year-long ethnic conflict. Because of the impoverished nature of the country, it is necessary to focus on utilising locally available materials, feedstuff and breeding stock rather than prohibitively expensive imported items.

Objectives

The objective of this program is to encourage villagers of Solomon Islands to increase output of

eggs and meat from their existing chickens through simple, improved husbandry practices. The increased output is necessary to improve villagers' protein-deficient diets and to provide small amounts of cash income from the sale of surplus meat and eggs.

At first glance, free-ranging poultry in a Pacific island village would appear to be an idyllic situation for the poultry keeper. However, there are many different problems that need to be addressed to maintain effective subsistence production. A project developed to address these problems is described.

Project activities

The main challenges faced in village poultry keeping are:

- regular and balanced feeding of the poultry from available local foods
- provision of specific poultry housing and confinement of the fowls for most of the day to avoid predators and enable location of eggs
- planned and structured breeding programs utilising available local stock
- poultry health and disease management without expensive imported medications.

These challenges have been successfully met by publication and utilisation of the training manual

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based on the principles of 'Kai Kokorako Perma-Poultry', which is a concept similar to backyard poultry keeping around the world. The name Kai Kokorako means 'eat chicken' in pidgin English and Perma-Poultry refers to the links of the concept to permaculture.

The main challenge to overcome in training exercises is to ensure that essential activities like feeding and management of confinement of the village poultry take place daily.

Feeding

While daily food for the family is routine, other food-gathering activities, such as gardening and protein gathering—whether fishing or hunting, may be engaged in weekly, seasonally or even have a cultural basis. The requirement for daily feeding of poultry has therefore been attached to the preparation of the main family meal of the day, so that the fowls are seen as an important extension of the family. While village food may be seen as of limited range and variety, the major hurdle of daily feeding of poultry is still assured.

The main source of food for the people is a garden, which almost every house, village or community has established. Depending upon the location of the village, protein sources are generally limited for both the people and poultry. If the village is close to the sea, then all manner of marine creatures could be available. If the village is further away in the bush, then other wildlife or small ponds of farmed fish are used. In addition, protein crops such as beans, peas and peanuts are grown in the village gardens.

Access to commercial feed is restricted due to both remoteness of the villages, erratic supply and the lack of funds to purchase it at much higher prices than apply in Australia. Training includes an attempt to provide the balanced dietary needs of specific age and sex groups of poultry from locally available resources rather than the expensive imports.

Three broad food groups are specified in training exercises: energy, protein and protective. As the villagers own diet is largely based on their food garden, a wide range of potatoes, yams, other vegetables and fruits is available to meet the energy food requirement. This range of food can be more limited depending on the location of the community and, of course, encouragement to establish poultry projects for more protein is part of the effort to

improve the balanced diet of the people. Nevertheless, marine creatures, insects (including termites) and other wildlife, as well as beans, peas and peanuts, are usually available in small quantities.

Protective elements come from a broad group of foods in which green food, grit and medicinal foods like chilli and pawpaw are included to simplify preparation and feeding.

Trainees are encouraged to use three receptacles (in this case, three different-coloured plastic buckets) to gather the food each day and it is then delivered in a free-choice manner via a three-compartment feeder such as an appropriately modified length of bamboo.

Substitution of chicken in village diets is also seen as an important factor to ease the pressure on dwindling wildlife as food sources. Once the training principles are implemented, the village poultry owners are not only able to provide an improved diet for their families but also can gain small cash incomes from the sale of surplus chickens and eggs.

Housing

Village poultry have in the past been allowed to roam freely around the houses without any specific feeding, and this has led to low production and survival rates, as well as a stunted, almost half-bantam size village fowl. Free-ranging birds are also susceptible to predation. Housing and confinement helps to control these problems.

Villagers are well aware of the losses of both adult and young birds to predators and the difficulty of locating eggs if a hen happens to be laying in the surrounding jungle. The need for appropriate housing is therefore easily understood and the poultry housing can be constructed from bush materials in a way very similar to the villagers' own homes. The chicken house is built to the same size and shape as a villager's home, with 'rooms' for specific age and sex groups of fowls.

The timber, bamboo and leaf construction is strong, weatherproof and, due to the leafy roof, is comfortable in the tropical heat. Strong bamboo and timber walls can ensure predators such as cats, dogs and pigs are excluded. Continuous hands-on care is necessary to manage the likely visits by snakes and rats.

Once the appropriate housing is provided, it is only necessary to attach the two main daily tasks of release and evening lock-up to other regular village activities at those times of the day.

Afternoon release has been attached to the normal rest period for villagers in the mid-afternoon heat, which ensures that most hens have laid and will not wander far at that time of the day. Return to the poultry house has then been attached to the setting of the sun when the poultry are naturally inclined to be looking to roost and they can be encouraged back to their perch with some grated coconut, or rice or other grain.

Breeding

Almost accidental infusions of the wild, red jungle fowl in many parts of Solomon Islands have also ensured that the body size of feral village fowls is kept small. From time to time, various pure and hybrid chickens and adult stock have also been randomly distributed throughout the country. Even so, existing bloodlines within the village fowl populations are seen as adequate for ongoing breeding for subsistence needs and genetic upgrade is not necessary. The natural qualities of semi-feral fowls such as foraging, broodiness and survival skills are complemented by the infusions of genetic material from the jungle fowl and pure and hybrid breeds.

Training

People of developing countries are also often hunters and gatherers rather than herdsmen, so many cultural and habitual attitudes also need to be considered.

Daily tasks such as provision of fresh water and feed, egg collection and breeding management activities are the major habits for the villager to acquire. Training in these improvement principles has been delivered to more than 250 villagers in their home areas over a 7-year period with some outstanding results. Many of these villagers were disadvantaged rural youth who were displaced due to the ethnic conflict. These youths were able to

establish successful chicken projects that made good contributions to their family and community food sources.

One particular supervisor of a youth group was so successful with his adoption of improved practices that he was able to pay high school fees for his son for a whole year. Several other youths were able to restore their self-confidence through participation in the workshops, and returned to tertiary studies or commenced new job training following a lapse because of the ethnic conflict. This training has been well accepted in the various communities where the students live, despite peer pressure on some students who were involved with the militants.

Endorsement of our training program by one influential local leader who himself operates a successful poultry enterprise has also dispelled the peer pressure from former militants. Many success stories arose from this 2-year project, including restoration of confidence to encourage former tertiary students to return to studies and others to commence new studies.

A 14-year-old boy who is one of five children in a family without a father was able to construct his own chicken house and set up a successful project following instructions from his mother. She had attended a Kai Kokorako workshop several years before.

Conclusion

As the benefits from proper village poultry husbandry and the development of small cash businesses from the surplus poultry and eggs are extremely valuable, work to promote future expansion of the training program across Solomon Islands is ongoing.

Other major projects involving further research into local garden produce for chicken feed and re-establishment of regional breeding stations/training centres are also in progress.

The AusAID Southern Africa Newcastle Disease Control Project: its history, approach and lessons learnt

Robyn G. Alders¹

Abstract

The Southern Africa Newcastle Disease Control Project (SANDCP) was born out of the realisation that village chickens are the most significant livestock species in terms of levels of ownership, access to animal protein and potential for earning cash income in each of the three countries that SANDCP is focusing on—Mozambique, Tanzania and Malawi. Village chickens are generally owned and managed by rural poor, usually women, and are usually run under a free-range, low-input–low-output management system.

Newcastle disease (ND) is a serious constraint reported by most village poultry keepers. Severe strains can cause up to 100% mortality in non-immune chickens. The principal problem for low-input management systems is that strategies for disease control are mostly absent. For ND control, thermotolerant vaccines, notably strain I-2 from Australia, can be manufactured in country and are cheap to manufacture and supply to village poultry owners. They are also simple to administer. While the technology exists to assist rural poultry producers, the challenge for this project has been to train stakeholders in the use of the vaccine, and to set up a sustainable manufacturing and distribution network for those areas where it is most needed.

This project followed on from and expands upon the Australian Centre for International Agricultural Research (ACIAR)/National Veterinary Research Institute of Mozambique (INIVE) ND control project, which ran from 1996 to 2001. The ACIAR/INIVE project demonstrated the effectiveness of I-2 vaccine under field conditions, developed and produced a comprehensive extension package and supported vaccination campaigns undertaken by government agencies and non-government organisations (NGOs). Vaccination campaigns using I-2 vaccine were conducted in trial zones from March 1999 and were continued under SANDCP in an increasing number of districts.

The goal of the project was to contribute to poverty reduction and increased food security in three countries of southern and eastern Africa. The purpose of the project was to assist the governments of Mozambique, Malawi and Tanzania develop and implement efficient and equitable ND control programs to improve smallholder, community and national welfare. The outcomes of the project were expected to be a strengthened capability of, and relationship between, stakeholders in order to successfully implement ND control programs in Mozambique, Tanzania and Malawi, and a decrease in chicken mortality rates caused by ND in project activity areas.

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There were four components to the project: community, vaccine, extension and project management. The project was implemented in collaboration with the relevant government departments (veterinary services, extension services and central veterinary laboratories) and some NGOs operating in project areas. The country coordinators were nominated by their respective country coordinating committees.

The key lessons learnt during the project were that:

- liquid I-2 vaccine administered by community vaccinators protects against outbreaks of ND when administered every 4 months
- improved village chicken production is of particular benefit to female-headed households
- village chicken farmers are willing to pay for ND vaccination services when these services are effectively administered
- female community vaccinators are more likely to remain working in their home areas than are their male counterparts
- training in administration at all levels is an essential component of an effective recovery program
- informing farmers about the transmission and control of ND by introducing them to the 'germ theory of disease' can benefit the control of other animal and human diseases.

Introduction and background

In March 2000, the Australian Agency for International Development (AusAID) and the Australian Centre for International Agricultural Research (ACIAR) co-funded a southern Africa regional workshop aimed at sharing information across borders on the impact of Newcastle disease (ND) in rural village chicken populations. The workshop also sought to assess the interest level of key stakeholders in the idea of a regional ND control project (GRM International 2005). As a result of this meeting, terms of reference were prepared for a feasibility design team to visit seven southern African countries to assess their capacity to be involved in such a project. The team visited South Africa, Botswana, Mozambique, Malawi, Zambia, Tanzania and Swaziland. The result of the design and feasibility study was a project with subprojects in three countries—Mozambique, Tanzania and Malawi.

The Southern Africa Newcastle Disease Control Project (SANDCP) was born out of realisation that village chickens are the most significant livestock species in terms of levels of ownership, access to animal protein and potential for earning cash income in each of the three countries that SANDCP is focusing on (GRM International 2005). Village chickens are generally owned and managed by the rural poor, usually women, and are run mostly under free-range, low-input–low-output management systems. ND is a serious constraint recorded by village poultry keepers. Severe strains can cause up

to 100% mortality in non-immune chickens. The principal problem for low-input management systems is that strategies for disease control are mostly absent. Newcastle disease is the most catastrophic disease, yet thermotolerant vaccines, notably strain I-2, can be manufactured in country and are cheap to manufacture and supply to village poultry owners. They are also simple to administer. While the technology exists to assist rural poultry producers, the challenge for this project has been to educate stakeholders about the use of the vaccine, and to set up a sustainable manufacturing and distribution network for those areas where it is most needed.

ACIAR has, over the past 15 years, supported projects that have aimed to find a sustainable solution to the problem of controlling ND in village chickens. The approach has been to develop vaccines that are relatively thermotolerant and so not completely reliant on a cold chain. Two vaccines have been developed from avirulent Australian isolates of ND virus. Strain NDV4-HR became a commercial vaccine. Strain I-2 was developed specifically for local production in developing countries, as it is not under patent (Bensink and Spradbrow 1999). The seed material was produced during an ACIAR project and is held at present at the University of Queensland. Seed material is made available without cost to developing countries that wish to test, and possibly produce, thermotolerant vaccine.

SANDCP followed on from and expands upon the ACIAR/National Veterinary Research Institute of

Mozambique (INIVE) ND control project, which ran from 1996 to 2001. The project demonstrated the effectiveness of I-2 vaccine under field conditions, developed and produced a comprehensive extension package and supported vaccination campaigns undertaken by government agencies and non-government organisations (NGOs). Vaccination campaigns using I-2 vaccine have been conducted in trial zones since March 1999 and the vaccine continues to be used in an increasing number of districts.

Project design

The goal of SANDCP was to contribute to poverty reduction and increased food security in three countries of southern and eastern Africa. The purpose of the project was to assist the governments of Mozambique, Malawi and Tanzania develop and implement efficient and equitable ND control programs to improve smallholder, community and national welfare. The project aimed to alleviate poverty in the short and long term by assisting all stakeholders to improve their ability to increase chicken and egg production through a decrease in ND occurrence. The main issues that the project dealt with included the following:

- There was a lack of official interest in village chickens—historically the emphasis for animal production has been on cattle rearing. Extension support for village chicken systems is poor or non-existent.
- Chickens were poorly managed—flocks of scavenging village chickens are raised with very

little input from villagers. They are seldom given any supplementary feeding, husbandry or veterinary inputs, which means diseases, especially ND, ravage the flocks and there are further losses, especially in young chicks, occasioned by starvation, predation and exposure.

- There was no distribution system for supply of the vaccine—while I-2 vaccine is thermotolerant, it still requires cold storage and cold transport to maintain maximum viability of the vaccine. The freeze-dried form that was produced in Mozambique will last longer out of cold storage, but the wet vaccine currently produced in Mozambique, Tanzania and Malawi requires a more reliable distribution system (Table 1). No effective cost-recovery system for vaccines administered to livestock in the family sector was in operation at the start of the project.
- Confidence in the vaccine was lacking—the project is closely monitoring outcomes of vaccine campaigns in new areas to ensure no ‘false beliefs’ are spread should there be mortalities following a campaign.

The project was designed with four components:

- Component 1: Community—to develop effective and sustainable community participation and ownership of a ND control program
- Component 2: Vaccine—to provide technical inputs required to support the development of an effective and sustainable ND control program
- Component 3: Extension—to provide effective training, education and awareness raising of relevant community members, NGOs and

Table 1. Comparison of the characteristics of ‘wet’ and freeze-dried I-2 Newcastle disease vaccine (Young et al. 2002)

Criteria	‘Wet’ I-2 vaccine	Freeze-dried I-2 vaccine
Training of personnel	Vaccine production and quality control	Vaccine production and quality control; operation and maintenance of freeze-drier
Vaccine container	Glass or plastic vials/eye-droppers that do not inactivate the vaccine virus; 100 and 250 doses	Glass vials, caps and rubber bungs, more expensive; 250 and 500 doses
Ease of use	Ready to use	Requires dilution
Shelf life at 4–8 °C	4 months	12 months
Shelf life at 9–30 °C	2 weeks	2 months
Shelf life over 30 °C	2 days	2 weeks
Recommended period of use after opening	3 days (1 drop per day)	2 days (1st day – 1 drop 2nd day – 2 drops)

vaccinators/village livestock workers in relation to ND control and poultry husbandry

- Component 4: Project management—to manage the project efficiently and effectively, meeting both the generalised standards outlined in AusAID’s guidelines and complying with the specific requirements of the contract between the Australian Government and the Australian managing contractor.

Major strengths

Major achievements of the project included:

- the ownership of the ND control program by villagers, and collaboration between stakeholders (including farmers, chicken traders, vaccinators, and village district and central authorities)
- increased awareness of the role of village chickens in poverty alleviation, food security and HIV/AIDS mitigation at all levels
- increased awareness of the components of a sustainable ND control program at all levels
- improved production of I-2 ND vaccine
- increased participation of women in ND control activities
- the establishment of diploma and certificate distance-education courses at the Open University of Tanzania
- effective implementation of ND control activities by national and international NGOs in collaboration with national government disease control programs
- production of a wide range of extension material (GRM International 2005).

Gender issues

Project activities have confirmed that village chicken raising is undertaken mainly by women and children, and that it is of significant benefit to them (GRM International 2005). The majority of the output indicators assessed during the baseline studies (flock size, off-take and mortalities) in female-headed households in Tanzania demonstrated improvements in the final year (Harun et al. 2009). Knowledge levels among women also increased significantly during the project. The project emphasised the need to train equal numbers of male and female community vaccinators and, in most cases, female vaccinators were less likely to drop out.

Sra Luisa Arnaldo is 36 years old and a widow with three children living in Chirodze Ponte, Mozambique. She started raising three chickens in 2000 but their 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 MZM500 (US\$0.025) per bird to the community vaccinator. In October 2004, she had 25 chickens and decided to sell five 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. All of her children attend primary school.

Sustainability

SANDCP paid close attention to issues of sustainability from the beginning of the project (GRM International 2005). Cost-recovery mechanisms were developed and/or refined in each country. The real costs of producing and distributing I-2 ND vaccine in each country were determined. By the end of the project, each country had opted for partial cost recovery, with Mozambican and Malawi governments subsidising the salaries of the vaccine production personnel but not consumables. In the case of Tanzania, a request to increase the Animal Diseases Research Institute (ADRI) vaccine sale price to a level that will ensure that essential non-personnel inputs are covered was sent to the permanent secretary who indicated that the sale price of the vaccine at ADRI could be increased once provisional registration was obtained.

In the field in each country, community vaccinators purchased vaccine and then charged farmers per bird to administer the vaccine. The cost per bird was approximately US\$0.02 with approximately one-third of this price covering vaccine purchase and two-thirds of the price providing a small income to the vaccinator.

Lessons learnt

The main lessons learnt include that:

- liquid I-2 vaccine administered by community vaccinators does protect against outbreaks of ND when administered every 4 months
- improved village chicken production is of particular benefit to female-headed households

- female community vaccinators are more likely to remain working in their home areas than are their male counterparts
- training in administration at all levels is an essential component of an effective recovery program
- village chicken farmers are willing to pay for ND vaccination services when these services are effectively administered
- informing farmers about the transmission and control of ND by introducing them to the ‘germ theory of disease’ can benefit the control of other animal and human diseases (GRM International 2005).

Discussion and conclusions

The outcomes of the project were a strengthened capability of, and relationship between, stakeholders in order to successfully implement ND control programs in Mozambique, Tanzania and Malawi, and a decrease in chicken mortality rates caused by ND in project activity areas (GRM International 2005; Harun et al. 2009).

SANDCP is expected to have a long-term impact (GRM International 2005). It has built the capacity of key stakeholders and established coordination mechanisms that each partner country plans to continue. The project has also shown that it is possible to work with resource-poor livestock owners and that these owners demonstrate a willingness to pay for a service that is effective and provided efficiently.

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Newcastle disease control using I-2 vaccine in Tanzania: country report

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Abstract

Village poultry play an important role in Tanzania, and increased production has the potential to improve food security and assist in poverty alleviation in rural populations. One of the major constraints to the improvement of village chicken production in Tanzania is Newcastle disease (ND). For the past 3 years, the Southern Africa Newcastle Disease Control Project (SANDCP) has been implementing a community-based ND control program, with the aim of improving the livelihoods of poor villagers in Tanzania through increased flock sizes and egg production.

It has been demonstrated previously that a sustainable, comprehensive Newcastle disease control program has four essential components that are highly interlinked:

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

SANDCP tackled these components. The project is an integrated program encompassing institutional strengthening of the government livestock sector and non-governmental organisations, and promoting rural community participation and ownership in Newcastle disease control. Poor knowledge of and skills in village chicken production among smallholder farmers, extension/veterinary extension officers, researchers, academics, and policymakers are identified as obstacles to the success of a ND control program. Therefore curriculum review and developing and producing a comprehensive extension package were accorded a high priority.

The major achievements of SANDCP in Tanzania are described in this paper, and experiences and lessons learnt are discussed.

Introduction

Village chickens play an important role in the livelihoods of rural Tanzanians. They are the most widely

and evenly distributed livestock species in the country, and are kept by 70% of rural households (i.e. 3.3 million of 4.6 million people). In addition to providing meat and eggs for home consumption or sale, they play an important role in village social life and are used during rituals and ceremonies, in traditional healing and as gifts to respected guests. Village chickens are generally owned and managed by women and the rural poor, and are especially important in female-headed households and those where women are caring for sick or disabled family

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members (Alders et al. 2000, 2001). The estimated village chicken population of Tanzania is around 26.4 million.

Newcastle disease (ND) is a major problem in the development of village chickens in Tanzania. The mortality rate in affected flocks may reach 90% and the disease sometimes devastates entire flocks during outbreaks. In the past, control of ND in village chickens had very limited success. Most of the vaccines used were heat-sensitive and supplied in vials containing a large number of doses (usually 1,000), which were not affordable to most rural farmers. A stringent cold chain was required for vaccine distribution, and this is lacking or deficient in most rural areas. The only practical method for controlling ND in village chickens is by use of thermotolerant vaccines.

In 1996, a laboratory and extension workshop on the production and testing of the thermotolerant I-2 strain of ND vaccine was conducted at the Animal Diseases Research Institute (ADRI) in Dar es Salaam, sponsored by the Australian Centre for International Agricultural Research (ACIAR). Following this workshop, I-2 vaccine was successfully produced using master seed provided by the University of Queensland. The vaccine was tested for safety and efficacy in commercial chickens kept under laboratory conditions and then evaluated under simulated village conditions using multi-age local chickens (Wambura et al. 2000). Following the laboratory trials, a nationwide field evaluation of the thermotolerant I-2 vaccine produced at ADRI was carried out. The study was coordinated centrally from ADRI and involved the Veterinary Investigation Centres (VICs) located in seven strategic agroecological zones. This study proved that the vaccine was safe, potent and efficacious under field conditions in Tanzania.

The Southern Africa Newcastle Disease Control Project (SANDCP) commenced in Tanzania in July 2002 and concludes in October 2005. The goal of the project is to develop a model for sustainable ND control in village chickens. This is an integrated program encompassing institutional strengthening of agriculture ministries and non-government organisations (NGOs), and promoting rural community participation and ownership. The ultimate aim is to enable the government to conduct or supervise vaccination campaigns throughout the country without the need for external sources of support and funding.

After consultation with stakeholders, two areas were selected for the implementation of project activities: Dodoma region in the central zone of the country and Mtwara in the south. These areas present contrasting socioeconomic characteristics. Dodoma has many cattle and village chickens, and village chickens from this region supply the urban markets of Morogoro and Dar es Salaam. Mtwara is less developed and village chickens are an important asset as the region has few cattle. The region has poor access roads, making farmers more reliant on local markets. Within these two regions, five villages were selected based on the level of village chicken ownership, presence of an extension worker and relative ease of access. One thousand households were initially involved.

Various approaches to ND control in villages have been tried in Tanzania. The SANDCP model promotes organised campaigns three times a year with strict adherence to a vaccination calendar and vaccination by community vaccinators at village level. The community vaccinators are local farmers selected by their community and trained in ND control. They benefit from the work by protecting their own birds against ND and receiving a small fee when vaccinating their neighbours' birds. The first SANDCP-supported vaccination campaign conducted in collaboration with community vaccinators was carried out in May 2003.

The focus of SANDCP in Tanzania has been on developing and producing a comprehensive ND control extension package, improving local production and quality control of I-2 vaccine, organising and implementing vaccination campaigns undertaken by government agencies and NGOs, and establishing effective cost-recovery mechanisms. These activities will be discussed under four major headings:

1. Capacity building
2. ND control extension package
3. Collaboration with stakeholders
4. Economic and technical sustainability.

Capacity building

SANDCP recognises that key stakeholders in ND control in village chickens need information, skills and technical support that will allow them to play their part. This was achieved through specific training courses (for example in English language or computer skills), workshops and/or the provision of relevant ND

control literature and extension materials. More than 600 people (farmers, community vaccinators, extension workers, chicken traders, laboratory personnel, NGO personnel, regional leadership, district leadership, council chairpersons, institute financial officers) benefited from the training.

A community extension program was developed to ensure participation of the community in the vaccination campaign and to strengthen the training and support given to extension workers and community vaccinators. The following modules were produced and presented:

Module 1: Adult learning, the learning process and changes in attitudes, group dynamics

Module 2: Community organisation—participatory rural appraisal (PRA)

Module 3: Participatory monitoring and evaluation

Module 4: Baseline data collection.

The activities focused on the training of community vaccinators and extension workers, and the monitoring and evaluation of the control program. The training of trainers, extension workers and vaccinators commenced in March 2003 in both Dodoma and Mtwara regions. Subsequent training of community vaccinators and extension workers was conducted by the regional trainers. The extension personnel (government and non-government, women and men) were trained in ND recognition and vaccination procedures, and appropriate gender-sensitive participatory extension methods. Farmers,

extension workers and veterinarians shared their experiences in training sessions in various parts of Tanzania. 'A training manual for trainers of community vaccinators' that had been developed through the project was tested during training of trainers and improvements suggested. Details of various training workshops are presented in Table 1.

One of the major challenges faced was how to encourage the participation of more women in training. To facilitate the participation of women, courses were held in or close to the villages, so that women could return to their homes at the end of each day. Where women lived some distance from the training location, discussions were held within the village to determine how best to facilitate their participation in the 3-day course. One solution was for two women from the same village to participate so that they could provide company for each other outside course hours.

Newcastle disease control extension package

The project worked hard to ensure that appropriate and relevant extension materials were designed and field-tested during the project. The ND flip chart and training manual were reviewed at a national planning workshop on ND control in 2004 and, later, a task force was set up within the auspices of the project.

Table 1. Training undertaken by the Southern Africa Newcastle Disease Control Project

Type of training	No. of people trained		
	Male	Female	Total
Computer training	1	1	2
English course	1	0	1
Laboratory workshop	5	4	9
Training of trainers	11	3	14
Participatory rural appraisal and baseline data collection 2005	18	3	21
Financial management	3	1	4
Extension workers workshops	70	8	78
Poultry husbandry	9	19	28
VETAID Newcastle disease (ND) control	5	7	12
Tuamoyo group training on ND control	0	12	12
Feedback and evaluation	26	13	39
Community vaccinators	160	114	274
Poultry sensitisation and planning	85	11	96
Chicken traders workshop	20	0	20
Southern zone stock management—vaccines	29	4	33

SANDCP materials were reviewed. Eight SANDCP documents were translated into Kiswahili. These were the calendar, the vaccine instruction leaflet, the ND leaflet, the registration sheet, the extension messages leaflet, the campaign preparation leaflet, price list and the flip chart. Other materials developed included:

- posters
- a pamphlet on ND and vaccination
- five leaflets on diseases (including ND)
- three other leaflets, on management and marketing
- a booklet on management and diseases in more detail
- a flip chart on separating birds
- a radio spot shot
- a radio/TV program
- a TV spot shot – video episodes
 - a song
- training courses at livestock training institutes
- a village chicken production manual.

Much time was spent to ensure that translation into the local language did not change the intent of the message and that images used were not confronting or misleading, or contained elements that distracted the audience. Rigorous pre-testing of all materials with representatives of the target audience before printing and release was essential.

Curriculum review

Village chickens as tools in poverty alleviation and livelihood improvement are largely underrated. Many reasons for this have been proposed including the constraints to productivity imposed by ND, the perception that commercial (foreign and improved breeds) chickens are superior to local breeds, and poor knowledge of and skills in village chicken production at all levels of the community. In an attempt to redress the deficits in knowledge and skills, a curriculum review task force was set up under the auspices of SANDCP. The task force comprised representatives from government ministries, universities, livestock training institutes, ADRI, the VICs, regional government and SANDCP staff and consultants. Their task was to review the current curricula relating to diseases and production of chickens, with a view to increasing the importance of village chicken production.

Collaboration with stakeholders

The project collaborated with a number of NGOs in Tanzania (including Plan International, Heifer Project International, VETAID, and World Vision International) to facilitate active and ongoing linkages with communities.

Following the success of vaccination campaigns in pilot villages, farmers and extension workers in other areas requested vaccination. During the third year, coverage doubled to approximately 2,000 households: in Dodoma nine non-project villages are now also vaccinating and an additional three wards in non-project areas, comprising 32 villages, are now vaccinating in Mtwara.

In both Dodoma and Mtwara, feedback and evaluation meetings were held after vaccination campaigns to evaluate the campaign, determine the vaccine requirements for the next campaign and plan the campaign in collaboration with the communities and vaccinators. Participants included livestock specialists from the livestock and agriculture departments, as well as regional and district administrators, division, ward and village officials, community vaccinators, farmers and representatives from participating NGOs.

The final feedback and evaluation meetings held under the auspices of SANDCP were conducted in Mtwara and Dodoma in September 2005. The workshops involved regional commissioners, district commissioners, district executive directors, district planning officers, members of parliament, chairmen of district councils and district livestock officers. Representatives of all NGOs and community-based organisations were also invited. Different leaders from all levels from regional to village (village chairmen) were invited.

Some of the important outputs that resulted from the meetings were:

- the recognition of rural chicken keeping as a reliable and viable weapon in the fight against rural poverty and food insecurity
- the inclusion of rural chicken keeping in district development plans as a priority item
- the allocation of funds at district level to act as a buffer or credit facility in case of any cash shortfall during mass-vaccination campaigns on the part of farmers, to be paid back later.

Delivery of the vaccine to large numbers of farmers when and where it is needed and in good condition has been challenging. It has generally been difficult to vaccinate high percentages of birds in targeted local-

ities, as many farmers prefer to wait to see if the vaccine works before trying it. Mortalities in some areas after vaccination have reduced the confidence of some farmers in the efficacy of the vaccine. A serious drought in the second year of the project had a major impact on bird numbers in participating households. While droughts cannot be controlled, the occurrence of this one provided an opportunity to demonstrate the important role that chickens play in household disaster-mitigation strategies.

Other challenges included the need to improve coordination among the many stakeholders involved in the program, especially linkages between community vaccinators and community leaders. Good communication was essential. The perception of the project as a 'cash cow' led to demands for handouts, especially bicycles, for community vaccinators.

One of most important lessons learnt was that the initial vaccination campaign should be scheduled to ensure that vaccinated birds develop good immunity before ND outbreaks are due. Organised campaigns three times a year and strict adherence to a vaccinator calendar are prerequisites.

Economic and technical sustainability

To promote sustainable production of acceptable quality I-2 ND vaccine in Tanzania, considerable time was devoted to improving the vaccine production environment, pursuing vaccine registration with the Tanzania Food and Drug Authority (TFDA) and establishing cost-recovery mechanisms. The production of I-2 ND vaccine was relocated to isolated and refurbished rooms in the Vaccine Production Unit at ADRI so that it would comply with the minimum requirements of TFDA good manufacturing practice (GMP) guidelines. Equipment was purchased to allow production to be scaled-up, and the electricity supply to the vaccine unit and ADRI was improved through provision of a standby generator. Logbook-documented maintenance schedules were established and used for all essential equipment, especially newly acquired items and the generators. Standard operating procedures for production and distribution were drafted.

One of the major challenges faced related to the understanding of the vaccine: what does thermotolerant really mean and what implications does this

have for vaccine storage and use? Trials were implemented to establish the shelf life of the vaccine and data-loggers were used to monitor vaccine storage conditions, especially in areas that experienced frequent power cuts.

Sustainability

For a comprehensive ND control program to be sustained after the project came to an end, it was essential that the vaccine and vaccination services be commercialised, and that there be markets for surplus chickens and eggs. The real costs associated with vaccine production and distribution, including direct costs, fixed costs, depreciation on equipment and general running costs were calculated. It was envisaged that a proportion of income derived from vaccine sales would be available to purchase fuel for the standby generator, to pay for equipment maintenance and repair costs, and to pay any staff overtime allowances associated with production. A four-tier price structure was proposed to ensure that all costs were covered at all levels and allow a small return to the community vaccinator. However, despite efforts to ensure that the sales price at ADRI reflected the true cost, the current price at which the vaccine is sold from ADRI does not cover the cost of production and distribution.

Adequate and efficient cost recovery requires that a revolving fund be set up and good record-keeping established to ensure that proceeds from vaccine sales are available when needed. All payments must also be made promptly, and preferably in advance. At farmer level, it is important to discuss options for payment (for example, payment in kind), why farmers are required to pay for this vaccine (compared to other vaccines) and what the funds are used for. It is crucial to explain to communities that payment to the community vaccinator is not 'pure profit'.

Institutional challenges to the sustainability of this activity occur at all levels. Laboratory staff in vaccine production often also have other duties. Although performance-based incentives for vaccine production staff were discussed, these have not been introduced. Decentralisation poses problems when dealing with an issue of national importance such as the control of ND, since central government has no direct control over the activities of extension and livestock personnel. A lack of suitably qualified and experienced personnel (e.g. accountants and electricians)

cians) has also led to difficulties. Short-term technical assistance was provided in the area of administration, and electrical work was contracted out to competent companies or individuals.

Registration of vaccine

ADRI, through the permanent secretary of the Ministry of Water and Livestock Development, has been granted provisional registration of I-2 ND vaccine by the TFDA and will work in collaboration with the TFDA to achieve full registration. A schedule of activities for eventual achievement of full registration has been agreed in ADRI, and staff members have been assigned responsibilities for working towards that goal. I-2 ND vaccine is also on the 'Essential drugs' list published by Veterinary Council of Tanzania.

Since I-2 ND vaccine is the first locally produced vaccine to be evaluated by TFDA, the process of registration is challenging. Discussions are under

way to determine the standard of GMP that is acceptable, justifiable and economical. It is important that those involved in managing vaccine manufacture work closely with regulatory authorities throughout whole process of registration.

Conclusion

In the project pilot areas, PRA activities were conducted in the selected villages in January–March 2003 and again in February 2005. The PRA revealed that ND vaccination campaigns were well-accepted by farmers in the project pilot areas. Chicken mortality had been reduced, and bird numbers in participating households had risen (Table 2). Both male and female beneficiaries reported an increase in consumption and sale of chickens and eggs.

Although the project had been operational in the Tanzanian target villages for only 2 years at the time of the final survey, data showed that vaccination of

Table 2. The impact of vaccination on flock size, mortality and off-take in two test regions in Tanzania

Parameter	Vaccinated (mean)		Non-vaccinated (mean)	
	Mtwara	Dodoma	Mtwara	Dodoma
Flock size	15.0	17.1	3.1	10.3
Chicken mortality	0.3	5.9	10.3	9.9
Off-take	2.9	6.7	2.2	4.3

Table 3. Data obtained during surveys conducted in Southern Africa Newcastle Disease Control Project target villages in 2003 and 2005 for six parameters associated with the control of Newcastle disease (ND)

Parameter	Proportion of villages (%)	
	2003	2005
Households vaccinating – Dodoma	11	89
– Mtwara	55	88
ND as main killer – Dodoma	97	70
– Mtwara	98	19
Forced sale due to fear of ND outbreak		
– Dodoma	43	35
– Mtwara	69	34
Seasonal consumption – Dodoma	23	13
– Mtwara	68	31
Female-headed households vaccinating – Dodoma	19	89
– Mtwara	0	100
Male-headed households vaccinating – Dodoma	10	90
– Mtwara	57	88

village chickens against ND every 4 months led to improvements in village chicken production in the project areas (Table 3). In the Dodoma and Mtwara regions in Tanzania, chickens were sold to assist with household food supply during the drought.

Participation and knowledge levels of male and female farmers interviewed were high by the last year of the survey, indicating that the extension and training methodologies adopted by SANDCP reached both groups effectively.

SANDCP has shown that it is possible to work with resource-poor livestock owners and that these owners demonstrate a willingness to pay for a service that is effective and provided efficiently.

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Newcastle disease control using I-2 vaccine in Mozambique

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Abstract

Newcastle disease (ND) is considered to be a disease of strategic importance in all provinces of Mozambique, and vaccination an effective method of preventing it. To implement ND control in village chickens, the National Directorate of Livestock (DINAP) has established a ND control strategy for the rural areas, to reduce the incidence of ND through immunisation using thermotolerant, live avirulent or inactivated vaccines. In the country, two types of vaccine are currently in use:

- I-2 (local production)—Gaza, Inhambane, Tete, Zambézia and Nampula provinces
- ITA-NEW (imported)—Maputo, Manica, Sofala, Niassa and Cabo Delgado provinces.

The ND control program using I-2 has been undertaken with support from the Southern Africa Newcastle Disease Control Project (SANDCP). SANDCP works in five provinces, namely Gaza, Inhambane, Tete, Zambézia and Nampula. The main activities developed during the 3 years of the project were:

- training of extension staff and community vaccinators
- acquiring and distributing the vaccine
- updating, reproducing and distributing extension material
- mobilising farmers and community leaders
- organising and carrying out the vaccination campaigns
- monitoring and evaluating the ND vaccination campaigns.

The vaccination campaigns using I-2 vaccine and with SANDCP support started in 19 districts (March 2003). They involved 5,990 farmers and 89,504 chickens were vaccinated. At the request of provincial and local governments, the number of districts rose to 46 (July 2005), and involved 21,504 farmers (46% of them women). Some 413,875 chickens were vaccinated. During the 3-year project, the efficiency of vaccine utilisation in the field was monitored. Percentage utilisation of the I-2 vaccine dispatched to the provinces was 29% in the first campaign and rose to 70% in the eighth vaccination campaign. To carry out the vaccination campaigns 1,053 vaccinators (295 women, 28% of total vaccinators trained) and 311 extension workers were trained in the five provinces.

Vaccine requirements are channelled from the provincial livestock services through the country coordinator at the National Directorate of Livestock to central laboratory. The cold chain for vaccine storage up to the district level was guaranteed for 78% of districts.

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In general, the vaccination campaigns were considered to be successful, in that an increasing number of the farmers were vaccinating their chickens against ND and they were eager for the campaigns to continue. The farmers who know the importance of vaccinating chickens are revaccinating their flocks regularly and are participating in every campaign.

Introduction

The single greatest impediment to the production of village chickens in most developing countries is Newcastle disease (ND). The University of Queensland in Australia developed a thermotolerant vaccine suitable for use in the control of ND in village chickens, with funding from the Australian Centre for International Agricultural Research (ACIAR) (Spradbrow 2001). In Mozambique's national strategy for ND control in rural areas, ND is considered a disease of strategic importance in all provinces and vaccination against it to be an effective method of prevention. To implement ND control in village chickens the National Directorate of Livestock (DINAP) has established a ND control strategy for the rural areas to reduce the incidence of ND through immunisation using thermotolerant, live avirulent or inactivated vaccines (DINAP 2004a).

Almost 75% of the Mozambican population lives in rural areas and with subsistence agriculture as its main source of income (INE 2001). The majority of these people have a tradition of poultry keeping, especially chickens. Village chickens are a suitable tool for food security and poverty alleviation in rural areas as they are:

- a source of income during periods of food shortages
- one of the most accessible sources of animal protein for the poorest communities
- useful for special traditional ceremonies and events in rural areas.

Types of Newcastle disease vaccines in use in Mozambique

Two types of vaccine are currently in use in the country:

- I-2 (produced in Mozambique)—in Gaza, Inhambane, Tete, Zambézia and Nampula provinces
- ITA-NEW (imported)—in Maputo, Manica, Sofala, Niassa and Cabo Delgado provinces.

ND vaccination in the family sector is performed by community vaccinators, animal health workers and extensionists. Administration is performed:

- three times a year for I-2 vaccine and once for ITA-NEW
- house to house or at assembly points
- for a payment per chicken of MZM500.00 for I-2 vaccine and gratis for ITA-NEW.

Southern Africa Newcastle Disease Control Project

The Southern Africa Newcastle Disease Control Project (SANDCP) follows on from and expands upon the ACIAR / National Veterinary Research Institute of Mozambique (INIVE) ND control project, which ran from 1996 to 2001. The project demonstrated the effectiveness of the I-2 vaccine under field conditions, developed and produced a comprehensive extension package and supported vaccination campaigns undertaken by government agencies and non-government organisations (NGOs). INIVE has become the Central Veterinary Laboratory under a new structure of Ministry of Agriculture.

GRM International, the company that successfully tendered, commenced implementation of the project in Mozambique on July 2002 and the end of the project was planned by October 2005, after a 4-month extension.

SANDCP goal and purpose

According to the memorandum of understanding signed between the Australian Government and the governments of Mozambique, Malawi and Tanzania, the main purpose of the project was to assist the governments of Mozambique, Malawi and Tanzania to develop and implement efficient and equitable ND control programs to improve small-holder, community and national welfare. SANDCP aimed to promote the vaccination of village chickens against ND using I-2 vaccine.

SANDCP components

The project had four components:

- community participation and ownership
- production, quality control and vaccine distribution
- training and extension services
- project management.

SANDCP target areas

The ND control program using I-2 was undertaken with support of SANDCP. As ND control with I-2 vaccine had been carried out since 1999 in the country, DINAP deemed it wise for the project to improve the quality of the ND control activities in areas where the vaccine was already in use and the Cahora Bassa district (a World Vision project area) was chosen as a pilot area. Additionally, SANDCP worked in other districts of five provinces, namely Gaza, Inhambane, Tete, Zambézia and Nampula (Figure 1).

I-2 ND vaccine was administered in five provinces and 46 districts:

- Gaza—Xai-Xai, Manjacaze, Mabalane, Guijá, Chokwé, Bilene, Chibuto and Massingir

- Inhambane—Inharrime, Panda, Jangamo, Homoíne, Morrumbene and Massinga
- Tete—C. Tete, Cahora Bassa, Changara, Tsangano, Magoé, Zumbo, Moatize, Angónia, Chiúta and Macanga
- Zambézia—Quelimane, Nicoadala, Namacurra, Morrumbala, Mocuba, Maganja da Costa, Pebane, Namarroi, Gurué, Alto Molocué, Milange and Inhassunge
- Nampula—Angoche, Murrupula, Mogovolas, Mecanta, Mongicual, Mossuril, Ilha de Moç, Ribaué, Mecuburi and Erati.

SANDCP partnerships

Government institutions

Government participants were DINAP; the National Directorate of Rural Extension (DNER); the Central Veterinary Laboratory (formerly INIVE); provincial directorates of agriculture (DPAs) for Gaza, Inhambane, Tete, Zambézia and Nampula; veterinary and extension services (SPPs and SPERS) from Gaza, Inhambane, Tete, Zambézia and Nampula; district directorates of agriculture (DDAs); and local government representatives at district and village level.

Geographic location: eastern part of southern Africa
Area: 799,390 km²
Population: 19,420,036
Proportion of population in rural areas: 75%
No. of village chickens: 22,310,927
Climate: inter-tropical
Capital: Maputo
Official language: Portuguese
Currency: Mozambican metical (MZM) (US\$1 = MZM24,500)



Figure 1. Map of Mozambique and some statistics on the country (Source: INE 2001)

Non-government organisations

NGOs participating were World Vision Mozambique, VETAID, Heifer International Project, Care International, Malhalhe, Action Aid, OIKOS, Corridor Sands, VETAZA and community vaccinators.

Donors

Donors were the African Bank, ACIAR, the Australian Agency for International Development, the International Fund for Agricultural Development and the Food and Agriculture Organization of the United Nations.

Evaluation of Newcastle disease control experiences from the ACIAR/INIVE project

Short-term advisers contracted by the SANDCP assessed the following areas:

- experiences and lessons learnt
- training needs at all levels
- monitoring and evaluation
- participatory monitoring and evaluation methodologies.

Findings

Experiences and lessons learnt

- In general, the vaccination campaigns were considered to be successful in that increasing numbers of farmers were vaccinating their chickens against ND and they were eager for the campaigns to continue.
- The experiences from these campaigns could serve as a good base to develop sustainable ND vaccination programs.
- The distribution system for supply of the vaccine must be clearly established.
- Gender issue plays an important role in village chicken production.
- The ND control activities must be integrated into mainstream government activities.

Training needs for all stakeholders involved in ND control

Training and extension methodologies were adapted to ND control activities in rural areas (i.e. in the family sector).

Participatory monitoring and evaluation

The project aimed to involve all stakeholders in the implementation and monitoring and evaluation

(M&E) of ND control activities (Bagnol et al. 2002). The community participation in the process of planning, implementation and monitoring of the vaccination campaigns worked in locations where extension services were strong and the initial vaccination campaigns were well implemented.

Recommendations

- Farmers should be actively involved in the process of ND control.
- The vaccine distribution system needs to be improved at all levels, including improving the cold chain for vaccine storage.
- Vaccination activities should be developed as a business opportunity for community vaccinators.
- Information flow and the use of that information requires constant attention in order to effectively monitor and evaluate ND control activities.

Participatory planning, implementation, monitoring and evaluation (P-PIME) processes

Community participation

Community participation is considered the most crucial aspect influencing ND control in the rural areas. For effective and sustainable participation and ownership of the ND control program, the community needs a range of skills, abilities and knowledge relating to chicken management and community organisation (Bagnol et al. 2002). This was achieved through community participation in activities implemented by SANDCP, which provided opportunities for developing these skills.

Implementation of the ND control plan and selection of community vaccinators to be trained was done during a planning session, with active participation of community leaders to ensure effective and sustainable community participation and ownership of a ND control program, considered the most crucial aspect influencing ND control in the field. The community vaccinators trained were equipped with record books, extension material and adequate bags for vaccine transportation. Community vaccinators, with the support of extension workers, planned the campaigns and determined the chicken population requiring vaccination.

Carrying out three baseline studies, using community participatory methods in Cahora Bassa, the SANDCP pilot area

The participatory rural appraisal (PRA) and baseline survey methods were prepared in the first 2 weeks of December 2002. In February 2003, the first PRA and baseline surveys were carried out with the assistance of government and World Vision staff. The follow-up surveys to measure the impact of the project were undertaken in Cahora Bassa in 2004 and 2005. The key indicators measured were reduced mortality rates, increased chicken numbers inclusive of domestic consumption and sales, increased numbers of participating farmers and increased coverage of vaccination campaigns (Table 1).

Development of monitoring and evaluation systems

In the project target districts, field visits were conducted with active participation of the farmers and community leaders, in order to monitor and evaluate previous campaigns, and to plan and determine vaccine requirement for upcoming campaigns by the government institutions, NGOs, the private sector and SANDCP personnel.

The data record sheets for community vaccinators, extension workers and supervisors were sent to the livestock and extension services at provincial and district level. At the request of local community leaders and local government, the project designed and produced a registration book for vaccinators. Extension/livestock staff and vaccinators visited farmers and local leaders 30 days after the campaigns to check the success of the vaccination campaign and the possible presence of other problems, to share information and plan other actions.

The project short-term adviser on epidemiology was involved in the review of the project M&E

system to ensure that it was compatible with M&E and disease-surveillance systems currently in use by the Ministry of Agriculture. Real-time reporting of ND outbreaks in village poultry is difficult because of the limited contact between villages and livestock/extension personnel who are mainly based in districts, with not all districts having coverage. The DINAP annual report emphasised that ND outbreaks are still under-reported by the provincial veterinary services to the veterinary epidemiological unit (DINAP 2004b).

The capacity to monitor ND outbreaks was added to the new version of the data record sheet to encourage villagers and extension workers at all levels to report ND outbreaks.

Linkage and communication

National and provincial workshops were carried out during the 3 years of the project, to strengthen the capability and relationship between stakeholders, share experiences, plan and coordinate ND control activities in order to successfully implement of the program in Mozambique.

Exchange visits between SANDCP country coordinators and laboratory technicians were also made as a way of improving information exchange and experiences about ND control programs in the three countries supported by SANDCP.

Carrying out national planning and coordination workshops

During the project life, three national planning and coordination workshops (one for each project implementation year) were held involving key stakeholders in the process of ND control (veterinary and extension services, research, NGOs and private sector), from provincial to national level.

Table 1. Comparative data collected in surveys in Mozambique in 2003 (baseline), 2004 and 2005

Indicators	2003	2004	2005
Number of chickens owned per household	6	13	15
Number of chickens consumed per household (in the month before the survey)	1	1	2
Number of eggs consumed per household (in the month before the survey)	1	3	5
Number of chickens sold per household (in the month before the survey)	0	1	1
Number of egg sold per household (in the month before the survey)	0	1	0
Number of chicken dying due to Newcastle disease (in the preceding 6 months)	10	8	5
Percentage of farmers vaccinating their chickens against Newcastle disease	15.7	69.4	73.0

The main aims of the workshops were:

- to gather together the partners interested in ND control in the provinces where the SANDCP was implementing the ND control activities
- for the first 2 years, to plan the project activities for the next year
- to evaluate the achievements of previous project year.

Key outcomes of the workshops

The workshops benefited the program by:

- allowing learning from shared experiences
- improving coordination between key stakeholders, from provincial to national level
- developing mechanisms to improve the planning, implementation and monitoring of the vaccination campaigns.

Recommendations

Recommendations from the workshops were that:

- vaccine requirements should continue to be channelled from the provincial livestock services (SPPs) through the country coordinator (DINAP) to INIVE (now referred to as the Central Veterinary Laboratory) and vaccine distribution should be through government channels as with other livestock vaccines
- the SPPs should monitor the cold chain at provincial level to ensure that vaccine is kept constantly below 10 °C until it reaches the district level (to maintain the quality of vaccine sent to the vaccinators)—SANDCP distributed maximum–minimum thermometers to the heads of SPPs in the five participating provinces
- the Central Veterinary Laboratory should develop mechanisms to ensure timely production and distribution of vaccine to the provinces and restart the production of freeze-dried vaccine according to DINAP requirements
- the livestock and extension services at provincial level should continue to improve the coordination with NGOs and the private sector in order to identify clearly the responsibility of each stakeholder in the process of ND control
- SPPs should request the quantity of vaccine according the district demand to avoid under-utilisation of vaccine by the vaccinators
- extension workers should be trained in collection and dispatch of samples for laboratory diagnosis to ensure that outbreaks of ND and apparent vaccination failures will be recorded and investigated by the Veterinary Epidemiology Unit.

Carrying out provincial planning and coordination workshops

The five provinces involved in ND control using I-2 vaccine carried out seven provincial planning and coordination workshops. The workshops were attended by government institutions and partners (NGOs, private sector and community vaccinators) from village to provincial level.

Recommendations

Recommendations from the workshops were that:

- the SPPs should continue to collect all vaccine requirements from the stakeholders at provincial level, including NGOs, and remain responsible for the requisition of the vaccine from INIVE and its delivery to the provinces
- the DDAs be responsible for the requisition of vaccine from SPPs and distribution to the vaccinators—the DDAs should plan funds through the National Agricultural Program (PROAGRI) to ensure that key districts have a reliable cold chain for vaccine storage
- local government, community leaders and the vaccinators should be responsible for community sensitisation and mobilisation with support of extension workers
- the implementation of the vaccination campaign, including planning of the campaigns and determination of the chicken population requiring vaccination, should continue to be led by the vaccinators with support from extension workers
- the collection of data from the vaccination campaign should be by the vaccinators with support from extension workers
- the livestock and extension services and NGOs should continue to mobilise funds for training and monitoring activities.

In addition, during the provincial coordination and planning workshops, the participants recognised that agreements between government agencies, NGOs and the private sector involved in ND control activities would be useful in terms of improving vaccine distribution and chicken/egg commercialisation.

Extension material

Updating, reproducing and distributing extension and training material

The project short-term adviser for extension was involved in updating the material on the basis of

feedback from the extension task force, provincial trainers and extension workers. The extension services (at national and provincial level) have taken the lead in distributing the extension material produced by SANDCP to all community vaccinators and extension workers. HIV/AIDS educational materials are always added to the extension material kits to raise awareness of village people to the disease and to demonstrate the ministry's and SANDCP's commitment to tackling the problem.

The following materials were updated:

- the training manual
- the community vaccinators' manual
- the extension workers' manual
- the ND flip chart
- the ND calendar
- ND pamphlets
- ND T-shirts and caps
- the community vaccinators' registration book.

A stock of extension and training material was provided by SANDCP to the extension services for ongoing training and vaccination campaigns after the end of the project.

Extension training

Training for provincial trainers

The first training of provincial trainers occurred in January 2003 when six technicians were trained to be provincial trainers. In February 2005, eight more technicians were trained at the request of the extension services to increase the number of trainers available in the provinces.

The provincial trainers, with support of the project, were involved in training extension staff and community vaccinators from government institutions and NGOs with appropriate gender-sensitive participatory extension methods, as listed in Table 2.

Each training course included information about the prevention and mitigation of HIV/AIDS.

Training extension workers

The provincial trainers trained 297 extension workers in the identification of ND, organisation of the campaigns, necropsy and collecting samples for laboratory diagnosis. Extension staff trained in collaboration with the project have been active in the field, supporting ND control activities. Extension workers have been involved in the preparation, implementation and monitoring of ND vaccination campaigns in collaboration with community vaccinators. To improve knowledge about organisation of vaccination campaigns and cost-recovery systems, exchange visits of extension workers were made between Tete and Zambézia provinces.

Training community vaccinators

During the project, 1,197 community vaccinators (374 were women, corresponding to 31% of all vaccinators trained) were trained in all five provinces. It was recognised during the monitoring visits that vaccinators trained more recently tended to handle the vaccine and complete the M&E data sheet more carefully and that closer supervision at the field level has contributed to better utilisation of the vaccine, through improved organisation of the vaccination campaigns.

Encouraging the participation of women in Newcastle disease control activities

The involvement of women is crucial to the success of the ND control program since it is well known that chicken raising is mainly the responsibility of women. A female vaccinator is able to work more easily with female farmers. Once female

Table 2. Field-training activities conducted in collaboration with the project in Mozambique

Province	Vaccinators		Extension workers	
	Male	Female	Male	Female
Gaza	250	89	68	14
Inhambane	120	30	56	5
Tete	148	156	44	11
Zambézia	182	41	38	3
Nampula	123	58	54	1
Total	823	374	260	34

farmers are better informed they can lobby their husbands to authorise payment for ND vaccination. It is hoped that the involvement of women will improve their social and economic position, without seriously affecting the established rules of the rural society itself. An increase in the number of women trained as vaccinators increased the confidence of women farmers in adhering to the vaccination program, and raised their capacity to take decisions. So, the SANDCP philosophy to emphasise participation of women to be trained as community vaccinators, and the potential to empower women through ND control, has been gradually addressed.

Tete, Gaza and Inhambane are the provinces of Mozambique with relatively larger numbers of cattle and goats and this may explain the larger number of women owning chickens compared to other participating provinces (Zambézia and Nampula) where the men give more importance to chicken raising due the lack of other livestock species. Bagnol (2001) said that the gender division in relation to animal raising is generally on the basis of the animal species raised, the most valuable for the men and the small animals for women (Table 3).

Vaccine production

A total of 3,275,750 doses of I-2 vaccine were produced and distributed to the five participating provinces (Gaza, Inhambane, Tete, Zambézia and Nampula) from March 2003 to July 2005, to carry out eight vaccination campaigns. Some 1,804,858 chickens were vaccinated (55% utilisation of the vaccine dispatched to the provinces), benefiting about 109,076 farmers in accordance with their requests.

Vaccination campaigns

SANDCP-supported ND vaccination campaigns using I-2 vaccine started in March 2003. They initially targeted 19 districts, involved 5,990 farmers and vaccinated 89,504 chickens. By July 2005, at the request of provincial and local governments, vaccination was implemented in 46 districts, involved 21,504 farmers (46% women) and 413,875 chickens were vaccinated.

In general, the vaccination campaigns were considered to be successful in that more and more farmers were vaccinating their chickens against ND and were eager for the campaigns to continue. The farmers who know the importance of vaccinating chickens are re-vaccinating their flocks in every campaign.

During the 3 years of the project in Mozambique, the efficiency of vaccine utilisation in the field was monitored. Percentage utilisation of the I-2 vaccine dispatched to the provinces commenced with a low of 29% in the first campaign and rose to 70% in the eighth campaign. The results shown in Figure 2 demonstrate an improvement in the utilisation of vaccine by the stakeholders involved in ND control activities.

Improvement of the cost-recovery system for vaccine production and distribution

Cost-recovery and administration workshops were held in Mozambique. The workshops involved administrators involved in the production, sale and distribution of I-2 vaccine in the Central Veterinary Laboratory and the provincial livestock services. The sale price of the I-2 vaccine was decided by

Table 3. Percentage of women participating in the 2005 Newcastle disease vaccination campaign in five provinces of Mozambique

Province	2005 vaccination campaign			
	Chickens vaccinated	Farmers involved		Percentage female farmers involved
		Male	Female	
Gaza	155,397	5,651	4,231	43
Inhambane	206,839	6,557	6,997	52
Tete	126,582	3,727	3,816	51
Zambézia	118,154	6,941	2,408	26
Nampula	132,564	4,768	2,371	33
Total	739,536	27,644	19,823	42

DINAP, with the price of vaccinating a bird being set at MZM500 (approximately US\$0.02).

To ensure sustainability of vaccine production and timely distribution of adequate quantities of vaccine, the SPPs reimburse the Central Veterinary Laboratory the cost of vaccine production and distribution. The SPPs pay MZM20,000 for a vial of 250 doses of vaccine provided and sell it, by credit, to the DDAs for MZM25,000. The DDAs are responsible for transporting the vaccine to the district and distributing it to the vaccinators with payment in cash or by credit of MZM25,000/vial. The DDAs use the money collected from the vaccinators repay their debts to the SPPs.

It is well understood at all levels in Mozambique that the ND vaccination campaigns have a positive impact on rural households, especially those with low financial resources. The benefits of contributing to cost-recovery of the vaccine are also recognised, with the result that distribution of the vaccine to the farmers on credit is gradually being eliminated and the funds from vaccine sales have been used to purchase consumables for vaccine production.

Vaccination as a business opportunity

To ensure sustainability of vaccination campaigns, the work of vaccinators should be done as a business to encourage more farmers to adopt the package. The idea is to raise the willingness of all farmers to pay for the vaccination services provided by the vaccinators. As vaccinators mobilise more farmers, they gain more from their activities. The vaccinators receive the vaccine from the DDA either by cash payment or on credit. Where vaccine is received on credit they pay for the vials of vaccine after the vaccination campaign, when they obtain the money from the farmers.

Sustainable ND control

Beyond the end of the project, the Ministry of Agriculture (MINAG) will continue to support ND control, which is considered by the government to be one of the priority approaches to directly combating poverty in rural areas. Funds will be available in PROAGRI Phase II for ND control at the request of

Table 4. Numbers of chickens vaccinated against Newcastle disease in eight campaigns in five provinces of Mozambique between March 2003 and March 2005

Province	Campaign							
	Mar 03	Jul 03	Nov 03	Mar 04	Jul 04	Nov 04	Mar 05	Jul 05
Gaza	20,491	20,920	22,360	25,029	38,638	55,243	50,722	104,675
Inhambane	11,374	15,776	14,954	29,617	32,176	83,865	112,054	94,785
Tete	27,153	29,617	28,006	39,882	78,282	61,941	50,560	76,022
Zambézia	12,526	22,319	30,623	30,825	71,031	55,520	54,821	63,333
Nampula	17,960	26,453	29,760	23,814	52,711	56,456	57,504	75,060
Total	89,504	115,085	125,703	149,167	272,838	313,025	325,661	413,875

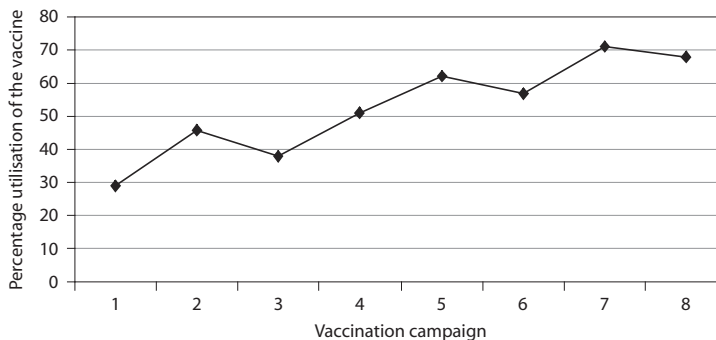


Figure 2. Percentage utilisation of I-2 vaccine for Newcastle disease control dispatched to the provinces in Mozambique

MINAG and donors. The MINAG team in charge of the M&E system for PROAGRI approved a set of SANDCP M&E indicators to be integrated into the ministry system. The indicators will be monitored jointly with the donors. Additionally, some of these donors are funding the SPPs activities directly and ND control could be funded by that means.

Conclusion

The project provided the technical inputs required to support the development of an effective and sustainable ND control program for village chickens. Mapaco (2005) demonstrated that vaccination against ND by community vaccinators using I-2 vaccine induced good levels of protection in chickens vaccinated. The study was carried out to monitor pre- and post-vaccination ND antibody levels in rural chickens.

The goal of the project was to contribute to poverty reduction and increased food security in Mozambique, and the PRAs revealed that ND vaccination campaigns were well accepted by farmers in the pilot areas of Mozambique (Cahora Bassa). Chicken mortality had been reduced with a consequent increase in bird numbers in participating households and the farmers reported an increase in consumption and sale of chickens and eggs.

In general, the vaccination campaigns were considered to be successful, in that increasing numbers of the farmers were vaccinating their chickens against ND, this indicating that ND vaccination campaigns are well accepted by farmers in the five participating provinces. The evaluation of vaccination campaigns in terms of impact is positive, although no baseline data are available to support the increase in number of chickens in participating households. During the monitoring visits, farmers and vaccinators confirmed a reduction in

mortalities due to ND and they were eager for the campaigns to continue.

In areas where ND control has been effectively implemented, farmers are seeing their chicken numbers increase and are asking for training in basic husbandry techniques, such as simple housing and supplementary feeding. The farmers consider chickens as the first step in animal-rearing activities, surplus chickens providing farmers with the funds to buy goats.

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Trials with a thermotolerant I-2 Newcastle disease vaccine in confined Australorp chickens and scavenging village chickens in Malawi

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Abstract

Vaccination trials were carried out in Malawi to determine the efficacy and potency of the I-2 Newcastle disease (ND) vaccine administered by eye-drop in Australorp chickens in the laboratory and in scavenging chickens in pilot trial villages. In the laboratory trial, which was on 61 Australorp chickens, comparisons were made for antibody response between vaccinated and unvaccinated chickens, and between vaccinated chickens and unvaccinated chickens housed together with vaccinated chickens. In the field trials, the vaccine was tested on 219 randomly selected, scavenging village chickens at three different pilot sites. Under the laboratory conditions, I-2 ND vaccine induced immune response in vaccinated chickens and spread by contact to unvaccinated chickens housed together with the vaccinated chickens, inducing in them an antibody response. In the villages, the vaccine induced an immune response in over 80% of the vaccinated chickens. The haemagglutination-inhibition (HI) titres remained high up to the 4th month at two trial sites but dropped to minimum protective HI titre at the third trial site. An increase in flock size was observed for the participating households, which was attributed to vaccination of chickens with the I-2 ND vaccine.

Introduction

Approximately 80% of rural families in Malawi keep chickens (Hüttner 2000) and chickens make the greatest contribution to household food security of all livestock species (DAHI 1999). Chickens are

used for consumption, sale, gifts, rituals and barter. Free-range scavenging rural chickens form about 71% of the chicken population in Malawi.

A major constraint to the expansion and increased productivity of the scavenging chicken population is the frequent devastation of flocks—reportedly up to

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90% of the flocks in some areas—by Newcastle disease (ND), which strikes during the hot, dry months of August through to November (DAHI 1999). Productivity could be enhanced if ND was controlled.

There are several conventional vaccines available for control of ND in the commercial poultry sector in Malawi. These have effectively controlled the disease and reduced the incidence in commercial poultry farms. However, some conventional ND vaccines, especially La Sota, that have been put to use in the control of ND in free-range rural scavenging chickens have yielded little success. Unconfined chickens, transport difficulties, high ambient temperatures and lack of refrigeration pose special problems for ND control in scavenging village chickens.

One solution to this problem is the use of vaccine strains of ND virus (NDV) that have been selected for thermostability and are affordable and simple to administer.

In 2003, the Government of Malawi through the Southern Africa Newcastle Disease Control Project (SANDCP) launched the I-2 ND project in collaboration with GRM International. The objective was to introduce the thermotolerant I-2 ND vaccine for the control of ND in village chickens in rural areas. Vaccination trials were carried out in the laboratory and in pilot villages before the vaccine was made available for wider use. Specifically, the trials were carried out with the following objectives:

- to measure the antibody response induced in laboratory chickens by vaccination with I-2 ND vaccine
- to confirm that the I-2 vaccine stimulates a protective antibody response in vaccinated scavenging village chickens under local conditions.

Materials and methods

Study location

Laboratory trials

The laboratory trial was carried out at the Central Veterinary Laboratory in the Lilongwe district of Malawi. The trial was conducted in two separate buildings: in one of the rooms in the chicken house located outside the main laboratory and in the isolation room located within the main laboratory building.

Field trials

The field trial was conducted at five villages in three different agroecological zones in the Central Region of Malawi. The pilot villages were Kamwana in Lilongwe district, Kapenuka in Dedza district, Mazombwe in Salima district, and Mbingwa and Chimkoko in Dowa district.

Farmers and community vaccinator identification and training

In preparation for the I-2 ND vaccine field trial, local assistants/community vaccinators were identified and trained in all aspects of ND control. Farmers who owned chickens and who volunteered to participate in the trial were identified and registered. All farmers who volunteered to vaccinate their chickens were considered a treatment group, while those that declined to vaccinate their chickens were considered a control group.

Experimental design

Laboratory trial

Seventy-two Australorp chicks were hatched and raised in a brooding house for 1 month. All chickens had received infectious bursal disease vaccine at ages of 10 and 21 days; while fowl pox vaccine was administered at the age of 11 weeks. The chickens were wing-tagged and blood sampled at day 23 to determine baseline titre and identify non-reactors to haemagglutination-inhibition (HI) test for testing the locally produced I-2 ND vaccine. Sixty-one, 4-week-old Australorp chickens, which had tested negative for ND antibody, were randomly allocated to experimental groups in the laboratory to test whether the locally produced I-2 ND vaccine stimulates an antibody response in vaccinated birds. Thirty-five chickens were housed in the isolation unit within the main laboratory, of which 25 were vaccinated. Ten chickens remained unvaccinated but were in contact with the vaccinated chickens throughout the experimental period. Twenty-six chickens formed a control group that was housed separately in the chicken house next to the breeding flock. The treatment group was vaccinated at ages of 35 and 54 days with batch 1 of I-2 ND vaccine diluted to yield 10^6 EID₅₀/dose.⁵ Serum samples were collected and HI antibody tested 2 weeks after each vaccination. A challenge trial was

⁵ EID₅₀ = 50% embryo infectious dose.

not carried out because there was no challenge NDV strain available in the laboratory and also for fear of infecting the breeding flock, which is located close to the laboratory experimental house.

Field trial

A total of 4,245 chickens were vaccinated in all the five sites. A sample of 219 chickens was randomly selected at three sites (Mbingwa, Kamwana and Kapenuka) for sero-monitoring. The selected chickens were individually identified using wing-tags on the first day of the field trial and bled to establish baseline sero-data for the chicken population at each site. They were vaccinated with I-2 ND vaccine administered by eye-drop. Sero-sampling continued at monthly intervals for 4 months after vaccination to monitor the levels and duration of the immunity. Birds belonging to farmers who did not vaccinate their chickens were used as a control group.

Two monitoring mechanisms were employed: sero-monitoring and monitoring of bird numbers. Sero-monitoring was used to determine the level and duration of immunity induced by I-2 ND vaccine, while monitoring of chicken numbers aimed at evaluating the impact of vaccination against ND.

Community vaccinators supervised by field veterinary staff administered the vaccine. Low-density polyethylene eye-droppers with a drop size of 20 μ L were used. The dose administered was $10^{7.3}$ EID₅₀.

Vaccine preparation

Propagation of the master seed

The master seed of the avirulent thermotolerant NDV (strain I-2) supplied by the Department of Veterinary Pathology of the University of Queensland was used as source of the test vaccine. The seed vaccine was reconstituted in 1 mL of sterile double-distilled water, then diluted with 19 mL of sterile phosphate-buffered saline (PBS). This was aliquoted as master seed virus (MSV) in 0.5 mL volumes and stored at -70 °C. A 10^{-1} dilution was prepared from the MSV in sterile PBS and subsequently propagated in 9-day-old embryonated chicken eggs from a minimum disease flock at the Central Veterinary Laboratory, Lilongwe, Malawi, (0.1 mL/embryo) via the allantoic cavity. The eggs were incubated for 96 hours at 37 °C. Thereafter, they were chilled at 4 °C for 24 hours, at which time allantoic fluids were harvested and tested for

haemagglutination. The infected allantoic fluids were then collected, pooled and dispensed in 1 mL aliquots, which were stored frozen at -70 °C as working seed virus.

The vaccine was prepared by inoculating a 10^{-3} dilution of the working seed virus into 9-day-old embryonated eggs, which were later incubated for 96 hours at 37 °C, then chilled overnight. The positive allantoic fluid was harvested and pooled.

Virus titration

The infectivity of the vaccine was determined by inoculation of 10-day-old embryonated chicken eggs with a 10-fold dilution series of aqueous I-2 ND virus. The EID₅₀ was calculated according to Reed and Muench (1938).

Serological assay

Laboratory chickens were bled before vaccination (day 0) and at day 14 and day 28 after vaccination. In the field trial, the wing-tagged birds were bled on the first day of the trial to establish baseline sero-data for the chicken population at each site and thereafter monthly. Pre- and post-vaccination sera were heat inactivated at 56 °C for 30 minutes and thereafter examined for HI antibodies to NDV. Examination for HI antibodies was done in 96-well V-bottom micro-titre plates using four HI units of NDV in 25 μ L of PBS and a 1% suspension of chicken red-blood cells as previously described by Allan and Gough (1974). Geometric mean titres (GMTs) were calculated for each group.

Data management and statistical analysis

Data were analysed using SPSS Statistics version 10 (Norusis 1990). Data were entered in SPSS data manager and cleaned by removing inconsistent and duplicate data. The serological and vaccination data were subjected to *t*-test to test if there were any differences between the treatment and control groups. Descriptive statistics including means and standard errors were also derived. Flock dynamics data were pooled before analysis. The hypothesis was tested at a 5% level of significance.

Results

Antibody response

Antibody response in laboratory chickens

All chickens were negative to NDV antibody before vaccination. The mean HI titre for the vaccinated group 2 weeks after first vaccination was 5.67 ± 0.23 and the titre had significantly increased 2 weeks after the second vaccination (6.21 ± 0.20 ; $P < 0.05$). The HI titre for the in contact unvaccinated chickens was significantly higher than the baseline HI titre (5.60 ± 0.64 ; $P < 0.05$). All control chickens were negative to NDV antibody (HI titre $\log_2 < 1$) throughout the trial (Table 1).

Antibody response in scavenging village chickens

At all the three sites, the percentage of chickens with HI titres greater than $\log_2 3$ was low at the beginning of the field trial, as shown in Table 2 (19% for Kamwana, 10% for Kapenuka and 2% for Mbingwa). At Kamwana and Kapenuka, over 80% of the sampled chickens had HI titres greater than $\log_2 3$ from the first month following vaccination up to the end of sero-monitoring. The number of birds

with HI titres greater than $\log_2 3$ at Mbingwa rose from 2% to 93% by the second month and then gradually declined to 63% at end of the trial (Table 2). Figure 1 shows the progression of GMTs (\log_2) at the three sites. HI titres greater than $\log_2 3$ are considered protective (Young et al. 2002).

The baseline GMT was significantly lower than the titre for the subsequent months ($P < 0.05$) and was below the protective level at all three places of study (Table 3). The GMT for chickens at Mbingwa rose above the protective level, then dropped to the minimum protective titre level by the 4th month post-vaccination (Figure 1 and Table 3). Geometric mean titres for chickens at Kapenuka and Kamwana similarly increased in the subsequent months but remained relatively higher than expected at the 4th month post-vaccination (Figure 1 and Table 3).

Chicken population dynamics and chickens vaccinated in the field

Chickens owned. The total chicken populations registered and owned by the households in the participating villages at the beginning of the field trial were 711, 982, 1,603, 736 and 574 for Chimkoko, Kamwana, Mbingwa, Kapenuka and Mazombwe, respectively. At the end of the trial, the total chicken populations were 902, 1,514, 1,593, 863 and 490 for

⁶ HI titre of less than $\log_2 < 1$

Table 1. Geometric mean HI antibody titres (GMTs) against Newcastle disease virus in different groups of experimental Australorp chickens

Group	Vaccine dose	Antibody response after vaccination					
		\log_2					
		Day 0 GMT		Day 14 GMT		Day 28 GMT	
		Mean	SE	Mean	SE	Mean	SE
Vaccinated ($n = 25$)	$10^{6.2}$	0.37 ^c	0.1	5.67 ^b	0.23	6.21 ^a	0.20
Contact ($n = 10$)	embryo	0.85 ^b	0.007	5.50 ^a	0.54	5.60 ^a	0.64
Control ($n = 26$)	infectious dose	0.79 ^a	0.16	0.58 ^a	0.10	0.00 ^b	0.00

^{abc} Means in a row within group with different superscripts differ significantly ($P < 0.05$)

Table 2. Percentage of chickens with HI titres greater than $\log_2 3$ at three study areas

Time	Percentage of birds with protective titre		
	Mbingwa ($n=46$)	Kapenuka ($n=31$)	Kamwana ($n=43$)
Pre-trial	2	10	19
1 st month	93	84	98
2 nd month	80	90	93
3 rd month	78	81	88
4 th month	63	94	100

Chimkoko, Kamwana, Mbingwa, Kapenuka and Mazombwe, respectively (Table 4). The sizes of the chicken flocks owned by participating households at the beginning of the trial did not significantly differ from the flock sizes of the same farmers at the end of the trial ($P > 0.05$) except at Chimkoko where there was a significant increase in number of chickens owned ($P < 0.05$) by the end of the field trial (Table 5).

Comparison of flock size between the vaccinating and non-vaccinating group at Kamwana (Table 6) showed a significant increase for the vaccinating group but a significant decrease ($P < 0.05$) for the households that did not participate in the first round of vaccination.

Chickens vaccinated. The number of chickens vaccinated during the first round of vaccination in comparison to total chickens owned by participating farmers was 1,442 of 1,603 chickens (90%) for Mbingwa; 922 of 982 (94%) for Kamwana; 700 of 736 (95%) for Kapenuka; 649 of 711 (91%) for Chimkoko; and 532 of 574 (93%) for Mazombwe (Table 4). The numbers of chickens vaccinated during the second round of vaccination were 1,227 of 1,593 (77%) at Mbingwa; 1,377 of 1,514 (91%) at Kamwana; 827 of 863 (96%) at Kapenuka; 727 of 902 (81%) at Chimkoko; and 475 of 490 (97%) at Mazombwe (Table 4). The average number of chickens presented and vaccinated by the partici-

pating households during the second round of vaccination was significantly higher than the number of chickens vaccinated during the first round of vaccination at Kapenuka, Kamwana and Chimkoko ($P < 0.05$; Table 5). The average number of chickens vaccinated during the first round of vaccination did not significantly differ from the number of chickens vaccinated during the second round at Mbingwa and Mazombwe ($P > 0.05$, Table 5). However, during both the first and second rounds of vaccination, the numbers of chickens presented and vaccinated by the participating households were significantly lower than the number of chickens owned ($P < 0.05$).

Impact of vaccination against Newcastle disease using I-2 ND vaccine

Mean flock size observed at the end of the trial was significantly higher than mean flock size at the beginning of the trial at Kapenuka and Kamwana ($P < 0.05$) but was not significantly different for Mbingwa, Chimkoko and Mazombwe (Tables 7a and 7c). Overall mean monthly opening flock size did not significantly differ from mean monthly closing flock size ($P > 0.05$). Monthly chicken increases for individual areas of study did not generally differ from flock decreases ($P > 0.05$) except for Kamwana in the months of September and

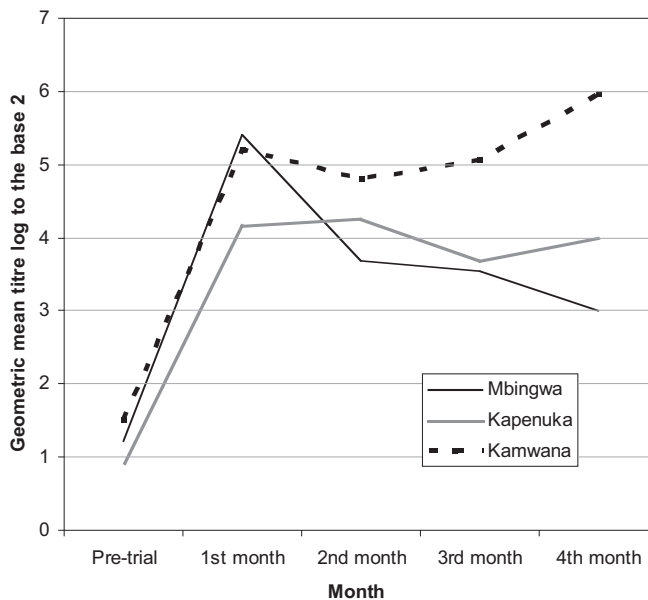


Figure 1. Geometric mean titres (Log₂) for three sites during the trial period

Table 3. *t*-test for geometric mean titre for vaccinated chickens at Mbingwa, Kamwana and Kapenuka

	Place of study					
	Mbingwa (<i>n</i> = 46)		Kapenuka (<i>n</i> = 31)		Kamwana (<i>n</i> = 43)	
	Mean	SE	Mean	SE	Mean	SE
Pretrial	1.02 ^d	0.12	0.90 ^d	0.34	1.51 ^c	0.30
1 st month	5.39 ^a	0.26	4.16 ^b	0.31	5.19 ^a	0.32
2 nd month	3.67 ^b	0.23	4.26 ^a	0.27	4.79 ^b	0.30
3 rd month	3.54 ^b	0.22	3.68 ^c	0.28	5.05 ^b	0.28
4 th month	2.99 ^c	0.34	4.00 ^{ab}	0.22	5.95 ^a	0.34

^{abcd} Means in a column within place of study with different superscripts differ significantly ($P < 0.05$)

Table 4. Comparison of birds owned against birds vaccinated during the first round and second round of vaccination

Site	First round of vaccination			Second round of vaccination		
	O	V	% vaccinated	O	V	% vaccinated
Chimkoko	711	649	91.28	902	727	80.60
Kamwana	982	922	93.89	1,514	1,377	90.95
Mbingwa	1,603	1,442	89.96	1,593	1,227	77.02
Kapenuka	736	700	95.11	863	827	95.83
Mazombwe	574	532	92.68	490	475	96.94

O = owned; V = vaccinated

Table 5. *t*-test comparing chickens owned by the vaccinating households at the beginning and at the end of the field trial; chickens vaccinated at the beginning and at the end of the field trial; chickens owned and chickens vaccinated for each round of vaccination

Parameter	Place of study									
	Mbingwa (<i>n</i> = 78)		Kapenuka (<i>n</i> = 64)		Kamwana (<i>n</i> = 102)		Chimkoko (<i>n</i> = 53)		Mazombwe (<i>n</i> = 50)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Number of chickens owned by the vaccinating group at the beginning of the trial	15.49 ^a	1.39	11.36 ^b	2.07	9.59 ^b	0.81	11.28 ^a	1.43	8.46 ^a	0.85
Number of chickens vaccinated at the beginning of the trial	14.86 ^{bc}	1.39	10.80 ^c	2.07	9.04 ^c	0.78	10.45 ^b	1.14	8.02 ^{bc}	0.84
Number of chickens owned by the vaccinating households at the end of the vaccine trial	15.63 ^a	1.44	13.48 ^a	1.95	11.02 ^a	0.93	13.30 ^a	1.28	8.94 ^a	1.28
Number of chickens vaccinated at the end of the trial	14.21 ^c	1.35	12.92 ^b	1.94	9.93 ^b	0.86	11.30 ^a	1.08	8.56 ^{ac}	1.25

^{abcd} Means in a column within place of study with different superscripts differ significantly ($P < 0.05$)

Table 6. *t*-test comparing chickens owned by vaccinating and non vaccinating households at the beginning and at the end of the field trial at Kamwana

Parameter	Vaccinating group (<i>n</i> = 102)		Non vaccinating group (<i>n</i> = 98)	
	Mean	SE	Mean	SE
Number of chickens owned at the beginning of the trial	9.59 ^b	0.81	15.74 ^a	1.25
Number of chickens at the end of the vaccine trial	11.02 ^a	0.93	2.98 ^b	0.55

^{abcd} Means within a column with different superscripts show significant differences between parameters ($P < 0.005$)

Kapenuka in the months of September and November where increases were significantly higher than decreases ($P < 0.05$; Tables 7a and 7c).

Generally, overall hatchings contributed significantly more to flock increases than chickens transferred into the flocks ($P < 0.05$; Tables 7b and 7d). The major factor contributing to chicken flock decreases in the SANDCP pilot sites was death due to disease, which was significantly higher ($P < 0.05$) than all other parameters that contributed to falls in chicken numbers (Tables 7b and 7d).

There was a significant decrease in chicken flock size for the farming families that did not vaccinate their chickens at Kamwana during the first round of vaccination ($P < 0.05$; Table 6). Due to insufficient data on chicken dynamics for the other four sites, no comparison was made of chicken flocks of non-vaccinating farmers at the beginning and end of the trial.

Discussion

Antibody response in laboratory chickens

The HI antibody titre in chickens vaccinated with I-2 ND vaccine was found to have (Table 1) significantly ($P < 0.05$) increased after the first vaccination (5.67 ± 0.23). Twenty-eight days after first vaccination (14 days after booster vaccination), the HI antibody titre in the vaccinated chickens significantly increased (6.21 ± 0.20). In unvaccinated birds housed together with vaccinated birds, the HI titre significantly increased to 5.50 ± 0.54 after first vaccination but did not significantly differ from the HI titre of the same treatment group observed 14 days after the booster vaccination was administered. Pre-vaccination levels of HI antibody were extremely low, and were still low in control chickens at the end of the trial, which indicates that unvaccinated control birds were not infected with ND virus during the laboratory trial. The higher antibody response in unvaccinated birds housed together with the vac-

inated group is an indication that lateral transmission of the I-2 ND vaccine virus occurred in the chicken house because of close contact of the housed birds (Spradbrow 1993/94). Almassy et al. (1979) observed that the eye-drop method of vaccination gave more uniform and better protection of chicks against NDV infection than administration in drinking water.

The antibody response observed in this study is similar to HI titres reported by other researchers. Rahman et al. (2004) observed a peak titre of $\log_2 5$ with V4HR-ND 30 days after first vaccination and 2 weeks after booster vaccination. Aini et al. (1987) also observed, 2 weeks after single vaccination with V4-UPM heat-resistant clone, a peak antibody titre of $\log_2 5$, which was within a range of 2–4 weeks for a peak titre reported by Spradbrow and Samuel (1987).

Antibody response in scavenging village chickens

The findings of this study show that the thermo-tolerant I-2 ND vaccine conferred protective immunity on vaccinated chickens. In almost all study areas, it was observed from the clinical picture that all chickens not presented for vaccination succumbed to ND. Results from one study area showed that the GMT for the sampled chickens declined to the minimum protective titre by the 4th month post-vaccination. The results suggest that chickens should be vaccinated with I-2 ND vaccine every 4 months to maintain protective immunity. This is consistent with the recommendation of Alders et al. (2003).

The serological results from Kapenuka suggest that vaccinated chickens were infected by circulating strains of ND virus, boosting their antibody levels. This is in agreement with the statement of Spradbrow (1993/94) that ND vaccination will prevent disease but not infection and is supported by the observation made during this trial of outbreaks

Table 7(a). Paired *t*-test comparing monthly mean opening and closing flock size; mean flock increase and mean flock decrease

Parameter	Month/study area																	
	September				October				November									
	Mbingwa		Kamwana		Kapenuka		Mbingwa		Kamwana		Kapenuka		Mbingwa		Kamwana		Kapenuka	
	Mean (n = 104)	SE	Mean (n = 105)	SE	Mean (n = 64)	SE	Mean (n = 102)	SE	Mean (n = 79)	SE	Mean (n = 100)	SE	Mean (n = 112)	SE	Mean (n = 104)	SE	Mean (n = 66)	SE
Total flock increase	2.92 ^e	0.45	3.25 ^e	0.45	3.34 ^e	0.64	3.25 ^e	0.48	4.08 ^g	0.65	4.02 ^f	0.66	3.53 ^e	0.88	3.57 ^e	0.52	3.37 ^f	0.63
Total flock decrease	3.02 ^e	0.50	1.79 ^f	0.31	1.82 ^f	0.38	2.65 ^e	0.39	1.62 ^h	0.28	3.22 ^f	0.50	3.08 ^e	0.80	3.01 ^e	0.41	1.78 ^g	0.37
Opening flock size	14.11 ^d	1.27	9.11 ^d	0.77	11.14 ^d	2.06	13.75 ^d	1.15	10.70 ^f	1.02	11.35 ^e	1.40	13.55 ^d	1.21	12.21 ^d	0.95	10.18 ^e	1.37
Closing flock size	14.15 ^d	1.26	10.10 ^d	0.88	10.11 ^d	1.42	13.10 ^d	1.22	12.86 ^e	1.18	11.75 ^e	1.50	14.66 ^d	1.18	11.90 ^d	1.04	10.63 ^e	1.47

^{def} Means within a column with different superscripts show significant differences between parameters

Table 7(b). Paired *t*-test for factors contributing to chicken population dynamics in the three geographical areas of study

Parameter	Month/study area																	
	September				October				November									
	Mbingwa		Kamwana		Kapenuka		Mbingwa		Kamwana		Kapenuka		Mbingwa		Kamwana		Kapenuka	
	Mean (n = 104)	SE	Mean (n = 105)	SE	Mean (n = 64)	SE	Mean (n = 102)	SE	Mean (n = 79)	SE	Mean (n = 100)	SE	Mean (n = 112)	SE	Mean (n = 104)	SE	Mean (n = 66)	SE
Hatchings	2.57 ^a	0.44	2.95 ^a	0.44	3.14 ^a	0.61	3.28 ^a	0.50	3.86 ^a	0.64	2.87 ^a	0.45	3.07 ^a	0.83	3.17 ^a	0.51	2.99 ^a	0.58
Transfers in	0.38 ^b	0.01	0.30 ^{bc}	0.10	0.20 ^b	0.13	0.17 ^c	0.01	0.25 ^{cd}	0.007	0.31 ^b	0.11	0.27 ^b	0.01	0.42 ^c	0.13	0.39 ^c	0.17
Deaths	1.96 ^a	0.49	0.75 ^b	0.25	0.80 ^b	0.23	1.26 ^b	0.27	0.34 ^{cd}	0.12	0.79 ^b	0.27	1.20 ^b	0.53	1.80 ^b	0.33	0.43 ^c	0.12
Transfers out	0.12 ^c	0.01	0.30 ^{bc}	0.12	0.11 ^b	0.01	0.34 ^c	0.15	0.29 ^{cd}	0.11	0.31 ^b	0.13	0.79 ^b	0.28	0.37 ^c	0.01	0.30 ^c	0.14
Predated	0.50 ^b	0.11	0.49 ^b	0.13	0.63 ^b	0.29	0.75 ^{bc}	0.20	0.44 ^c	0.15	0.51 ^b	0.13	0.58 ^b	0.20	0.44 ^c	0.14	0.34 ^c	0.20
Run over by car	0.00	0.00	0.00	0.00	0.00 ^c	0.00	0.00	0.00	0.00	0.00	0.00 ^d	0.00	0.00	0.00	0.00	0.00	0.003 ^e	0.003
Theft	0.00	0.00	0.00	0.00	0.00 ^c	0.00	0.00	0.00	0.10 ^d	0.01	0.00 ^d	0.01	0.00	0.00	0.00	0.00	0.22 ^d	0.14
Slaughtered	0.54 ^b	0.10	0.20 ^c	0.01	0.28 ^b	0.11	0.25 ^c	0.01	0.64 ^b	0.12	0.19 ^c	0.01	0.39 ^b	0.10	0.47 ^c	0.12	0.57 ^b	0.14

^{abcd} Means within a column with different superscripts show significant differences between parameters

of ND at Kamwana and Kapenuka, especially in households that did not vaccinate chickens during the first round of vaccination.

Chickens vaccinated and chicken population dynamics

Chicken flocks owned and vaccinated

The size of chicken flocks owned by participating households in this study ranged between 8 and 15 and is consistent with the findings of the National Livestock Development Master Plan (DAHI 1999), which reported a national average chicken flock size of 7.5, and of Hüttner (2000) who observed a flock size of 17 in northern Malawi. This suggests that flock sizes of the chicken population in Malawi are variable.

The increases in chicken numbers presented during the second round of vaccination at Kamwana, Kapenuka and Chimkoko are an indica-

tion of farmers' increasing confidence in I-2 ND vaccine in the SANDCP pilot areas.

A fall in the number of chickens vaccinated at Mazombwe was noted during the last round of vaccination and was attributed to high chicken mortalities reported in some households after the first round of vaccination. Low presentation of chickens for revaccination at Mbingwa was due to lack of interest by some farmers. Since no ND outbreaks were manifested at Mbingwa during the field trial, farmers did not experience the impact of ND outbreaks. Therefore some farmers were content with the first vaccination and did not see the need to revaccinate their chickens.

Household flock dynamics

Results of the flock dynamics study showed that there were more increases than decreases in flock size. There were also more intakes (transfers in) than exits (transfers out) of chickens from the flocks.

Table 7(c). Overall paired *t*-test comparing monthly mean opening and closing flock size; mean flock increase and mean flock decrease

Parameter	Month					
	September		October		November	
	Mean (<i>n</i> = 275)	SE	Mean (<i>n</i> = 259)	SE	Mean (<i>n</i> = 254)	SE
Opening flock	11.59 ^a	0.76	12.40 ^a	0.69	12.07 ^a	0.67
Total flock increase	3.16 ^b	0.29	3.65 ^b	0.33	3.43 ^b	0.41
Total flock decrease	2.32 ^c	0.25	2.46 ^c	0.22	2.68 ^c	0.35
Closing total	11.72 ^a	0.69	12.21 ^a	0.65	11.57 ^a	0.71

^{abc} Means within a column with different superscripts show significant differences between parameters

Table 7(d). Overall paired *t*-test for factors contributing to chicken population dynamics in the three geographical areas of study

Parameter	Month					
	September		October		November	
	Mean (<i>n</i> = 275)	SE	Mean (<i>n</i> = 316)	SE	Mean (<i>n</i> = 283)	SE
Hatchings	2.82 ^a	0.27	3.63 ^a	0.30	3.08 ^a	0.40
Transfers in	0.31 ^d	0.006	0.23 ^e	0.06	0.35 ^e	0.01
Deaths	1.22 ^b	0.22	1.21 ^b	0.15	1.23 ^b	0.25
Transfers out	0.18 ^d	0.005	0.32 ^d	0.11	0.50 ^c	0.12
Predated	0.52 ^c	0.009	0.74 ^c	0.11	0.47 ^c	0.11
Run over by car	0.00	0.000	0.000	0.000	0.0025 ^d	0.002
Theft	0.003 ^e	0.001	0.003 ^f	0.005	0.007 ^d	0.004
Slaughtered	0.35 ^c	0.005	0.41 ^d	0.005	0.46 ^c	0.007

^{abcdef} Means within a column with different superscripts show significant differences between parameters

These observations are contrary to the findings of Gondwe (2004) who reported more exits of growing adult chickens from the flocks than intakes into flocks. The main purpose of chickens migrating into flocks as reported by Gondwe (2004), is breeding. Gondwe et al. (1999) observed that farmers in northern Malawi acquired or exchanged breeding stock with their friends and relatives.

Chicken mortality

Farmers in all study areas indicated that chick mortality constituted a high proportion of chicken losses. Gondwe (2004) observed that chick mortality was mostly age related, with high mortality of chicks occurring during the first 5 weeks and that cumulatively over half of the chicks were lost by 20 weeks. Hüttner (2000) reported losses of up to 59% in chicks below 8 weeks of age. In Tanzania, Dessie and Ogle (2001) reported chick mortality of 61% by the age of 10 weeks. Missohou et al. (2002) reported chick mortality of 43% in Senegal, while in Zimbabwe, Permin and Pedersen (2000) observed 50% chick mortality in ND-vaccinated, free-range flocks by the 12th week of age, being highest during the first 3 weeks. Kyrsgaard et al. (1999) also reported chick mortality of 20% per month in ND-vaccinated flocks. After 5 weeks of age, low subsequent mortality rates were also reported by Kondombo et al. (2003) in Burkina Faso (8.8%) and Demeke (2003) in Ethiopia (4.6%). These figures indicate the extent of problems associated with chicken health and husbandry in villages.

High chick mortality could be attributed to nutritional problems. Permin and Bisgaard (1999) reported that diseases related to poor nutrition dominate the causes of early chick mortality. Though not quantified, common causes of chick mortality include external parasites (especially fleas), adverse weather conditions, predation and various unspecified diseases. High early chick mortality is therefore an important component of rearing losses in scavenging village chickens. However, as perceived by Permin and Pedersen (2000), preventing rearing losses by controlling diseases appears to be just part of the solution.

In Bangladesh, when chick baskets were used to confine chicks, they reduced early chick mortality to 3% (Ahamed 2000). The Danish International Development Agency project in central Malawi and

Ahlers (1999) in northern Malawi attempted enclosing chicks with baskets. This requires that chicks and the mother hen be fed during enclosure, an issue that requires investigation if the technology is to be accepted by farmers in Malawi.

Apart from chicken mortality due to diseases, predation also contributes to chicken losses. Chicken loss due to accidents is not an important factor in the study areas of this work.

Impact of vaccination against ND using I-2 ND vaccine

In this study, increases in flock sizes for the vaccinating households were observed at two study areas while flock size was maintained at the other three sites. In contrast, a significant decrease in the sizes of chicken flocks of non-vaccinating farmers was observed at one of the study areas. It can therefore be concluded from these results that vaccination against ND using I-2 ND vaccine had a positive impact on chicken flocks in all the participating villages. Controlling ND using the locally produced I-2 ND vaccine should be considered a viable technology capable of improving the production levels of scavenging village chickens. Full village chicken production potential can, however, be realised only if chicken losses, especially chick mortality and predation, are reduced through improved chicken husbandry.

Conclusion

This study has shown that the locally produced I-2 ND vaccine induces high antibody levels in vaccinated chickens and confers protective immunity against natural challenges of ND in scavenging village chickens. The I-2 ND vaccine virus is also capable of spreading to unvaccinated chickens housed together with the vaccinated chickens under confinement, inducing in them an antibody response. Flock sizes of the vaccinating farmers had either increased or were maintained while the flock sizes of the non-vaccinating farmers had decreased due to chicken mortalities. The serological results also confirmed the recommendation the chickens should be vaccinated with I-2 ND vaccine every 4 months. The study shows conclusively that vaccination using locally produced I-2 ND vaccine can benefit the scavenging chicken industry in Malawi.

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Southern Africa Newcastle Disease Control Project impact studies: baseline and participatory rural appraisal results

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Abstract

In economic terms, the direct cost of Newcastle disease (ND) is considerable. For example, it is estimated that 30–80% of the 27 million village chickens in Tanzania die annually from ND. Village chickens sell for approximately A\$2.70–4.00 per bird. At a 30% mortality rate, the minimum direct annual cost of uncontrolled ND is A\$21,870,000.

Results of surveys of randomly selected members of the Southern Africa Newcastle Disease Control Project target groups in Mozambique and Tanzania show a statistically significant reduction in mortality in vaccinating households and an associated increase in flock size. Equally, in both countries, increasing numbers of farmers are demonstrating their willingness to pay community vaccinators to vaccinate their birds. Poor rural families in particular benefit from increased numbers of chickens and eggs, leading to improved nutrition and food security, and poverty alleviation.

Introduction

Malawi, Mozambique and Tanzania have been partners in the Southern Africa Newcastle Disease Control Project (SANDCP), which promotes the

local production and quality control of I-2 thermo-tolerant Newcastle disease (ND) vaccine (Bensink and Spradbrow 1999), its administration by community vaccinators and the establishment of effective cost-recovery mechanisms. The goal of

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SANDCP is to assist the governments of Mozambique, Malawi and Tanzania to improve rural food security and the livelihoods of the rural poor.

One baseline and two repeat surveys of randomly selected members of the SANDCP target groups in Mozambique and Tanzania were carried out to assess impact. The objectives were to identify significant changes that occurred in the target population through project intervention and to assess the differential degree of change according to gender, and whether or not households were vaccinating their chickens against ND. SANDCP concentrated on the establishment of local production, quality control and testing of I-2 vaccine in Malawi, and the results documenting the successful implementation of laboratory and field trials are presented elsewhere in these proceedings (Mgomezulu et al. 2009).

Materials and methods

In Tanzania, two contrasting regions, Dodoma and Mtwara, were selected as project areas. Dodoma has many cattle and village chickens, with village chickens from this region supplying the urban markets of Morogoro and Dar es Salaam. Village chickens are an important asset in Mtwara as the region has few cattle.

In Mozambique, the Cahora Bassa district, Tete province, was chosen to be the area where the project would interact more intensively with field activities in order to measure the impact of ND control activities during the life of the project. The Cahora Bassa District was chosen as the pilot area because the Australian Agency for International Development (AusAID) sponsored and World Vision International (WVI) implemented Chiembekezo Food Security Project commenced at approximately the same time as SANDCP. Within the district, the project worked in WVI areas and areas supervised by government services.

The survey approach was designed and conducted by SANDCP in collaboration with government partners, and included questions on flock production, awareness about ND control, knowledge about ND and its control, and changes in attitudes and practices. In Tanzania, the initial baseline survey was implemented in April–May 2003, and there were repeat surveys in February 2004 and February 2005. Data were collected by local government staff at each location, and entered and analysed by SANDCP. For each year, the sample comprised a total of 200 house-

holds selected using systematic random sampling from the project villages, i.e. 20 households from each of 5 villages in Mtwara region and 5 villages in Dodoma region. Approximately half the sample was made up of female respondents. The data were entered and analysed using the Statistical Package for the Social Sciences (SPSS). The Mann Whitney test was used to compare quantitative variables and the chi-square test was used to compare proportions.

In the project pilot area in Mozambique, monitoring activities were conducted in all selected villages in January 2003. The exercise was repeated in March 2004 and January 2005.

Tanzanian results

Mean flock size

The mean flock size, calculated from estimates of the numbers of adult chickens, growers and chicks owned by each household at the time of each survey, was significantly higher in households that vaccinated the recommended three times in 2004 (i.e. in January, May and September; mean = 15.9 ± 1.3 SE) than in those that never vaccinated (mean = 6.5 ± 1.4 SE; $P = 0.0001$). At a regional level, the difference in flock size was highly significant in Mtwara (Table 1).

Chicken mortality

Mortality of chickens was calculated from estimates of the numbers of adults, growers and chicks that died in the 6 months prior to each survey and was significantly lower in households that vaccinated the recommended number of times (Table 1).

Mean total off-takes

The total off-take comprises chickens eaten by the household, sold, exchanged, given to guests or eaten in ceremonies in the 3 months before each survey. Mean total off-takes were higher for households that vaccinated every 4 months than for the households that never vaccinated (Table 1).

Households vaccinating chickens against Newcastle disease

The percentage of households vaccinating chickens against ND increased significantly in both Dodoma and Mtwara ($P = 0.0001$). Gender disaggregated data for this indicator are given in Table 2.

Identification of Newcastle disease as the main cause of mortality

The percentage of respondents identifying ND as the main cause of mortality in their flocks decreased significantly in both Dodoma and Mtwara ($P = 0.0001$) (Table 2).

Forced sale of chickens due to fear of Newcastle disease

The percentage of farmers that were forced to sell their chickens due to fear of ND outbreaks also fell. In Mtwara the decrease was significant ($P = 0.0001$).

Seasonal consumption of chickens due to fear of Newcastle disease

The consumption of chickens due to fear of ND outbreaks decreased significantly ($P = 0.0001$) in Mtwara but was not significantly different in Dodoma (Table 2).

Farmer knowledge

Three main areas of knowledge were assessed; namely the signs of ND, how ND is transmitted to chickens and knowledge about ND vaccination. Between the baseline and final-year surveys, the percentage of chicken-owning households knowing about key aspects of ND and its control showed an upward trend for all but one of the indicators measured. In Dodoma there were significant increases in the number of households knowing that

chickens should be vaccinated three times a year and that vaccination can be administered by eye drops (Table 2). In Mtwara there were also significant increases in knowledge, including that the incubation period for ND is approximately 1 week (Table 2).

Gender disaggregated output indicators

For the majority of the output indicators (flock size, off-take and mortalities) the estimates for female households in both regions demonstrated improvements in the last year of the survey compared with baseline findings. The estimates for the male-headed households were not significantly different. In the baseline-year survey male respondents knew more about ND vaccination than female respondents. By the final year survey, the males and the females had similar levels of knowledge.

Mozambican results

The percentage of households that had ever vaccinated against ND rose from 21% at the beginning of the project to 73% at the time of the last survey 2 years later.

The mean flock sizes of households that vaccinated the recommended three times in 2004 had significantly higher flock sizes than those that never vaccinated.⁸ The average flock size of the households that vaccinated the recommended three times was 16.3,

⁸ Throughout the report anything above or equal to 90% probability is classified as significant.

Table 1. Data on flock size, chicken mortality and total off-takes obtained during surveys conducted by the Southern Africa Newcastle Disease Control Project with households (HHs) in target villages that vaccinated three times in 2004 against Newcastle disease (ND) and those HHs that never vaccinated. The mean, standard error and significance of each result are shown.

Parameter	Vaccinating HHs	Non-vaccinating HHs	Significance
Flock size			
– Dodoma	17.1 ± 2.1	10.3 ± 2.4	$P = 0.067$
– Mtwara	15.0 ± 1.6	3.1 ± 0.8	$P = 0.0001$
Chicken mortality			
– Dodoma	5.9 ± 1.5	9.9 ± 5.3	$P = 0.351$
– Mtwara	0.3 ± 0.2	10.3 ± 7.6	$P = 0.0001$
Total off-takes			
– Dodoma	6.7 ± 0.9	4.3 ± 1.8	$P = 0.095$
– Mtwara	2.9 ± 0.4	2.2 ± 1.3	$P = 0.018$

whereas in the households that never vaccinated the mean size was 11.8. The flock sizes for the households that vaccinated in all five project campaigns were also significantly higher, averaging 18.1. Production, off-take and mortality data in vaccinating villages surveyed in 2003, 2004 and 2005 were significantly different ($P < 0.01$) in all cases between the initial and final surveys (Figure 1).

There was a significant drop in the number of households identifying ND as the main cause of mortality in chicken flocks, from 78% in the pre-project period to 63% in project year 2. The percentage of farmers selling because of fear of ND had dropped to 15% in project year 2 from 33% previously.

Mortalities over the previous 6 months were compared between vaccinating and non-vaccinating villages and found to be significantly less in vaccinating villages (Table 3). To overcome the inherent

differences due to location, the mortalities were compared on a per-bird basis (i.e. the number of mortalities reported was divided by the number of birds in the household flock).

There were no significant differences in knowledge between male and female respondents about the clinical signs of ND, except in year 2 when 33% of females and 12% of males were able to identify twisted necks as a clinical sign. Higher percentages of males were able to identify three of the five reasons for the transmission of ND in project year 2. These differences were statistically significant. In project year 2, there are statistically significant differences between the knowledge levels of males and females for four of the six variables used to measure knowledge about vaccination practices. In all cases, the percentage of males knowing about the vaccination practice was higher than the percentage of females.

Table 2. Data obtained during surveys conducted in the Southern Africa Newcastle Disease Control Project target villages in 2003 and 2005 for nine parameters associated with the control of Newcastle disease (ND). The percentage and significance for each result are given, together with the absolute number of responses in brackets.

Parameter	2003 (%)	2005 (%)	Significance
Households vaccinating chickens against ND			
– Dodoma	11 (11)	89 (91)	$P = 0.0001$
– Mtwara	55 (55)	88 (88)	$P = 0.0001$
Female-headed households vaccinating chickens against ND			
– Dodoma	19 (4)	89 (23)	$P = 0.0001$
– Mtwara	0 (0)	100 (4)	– ^a
Male-headed households vaccinating against ND			
– Dodoma	10 (8)	90 (68)	$P = 0.0001$
– Mtwara	57 (55)	88 (84)	$P = 0.0001$
Identification of ND as main cause of mortality			
– Dodoma	97 (92)	70 (70)	$P = 0.0001$
– Mtwara	98 (90)	19 (19)	$P = 0.0001$
Forced sale of chickens due to fear of ND			
– Dodoma	43 (42)	35 (30)	NS ^b
– Mtwara	69 (69)	34 (24)	$P = 0.0001$
Seasonal consumption of chickens due to fear of ND			
– Dodoma	23 (22)	13% (12)	NS
– Mtwara	68 (67)	31% (27)	$P = 0.0001$
Farmer knowledge in Dodoma of need to vaccinate chickens against ND three times a year	35 (34)	63 (64)	$P = 0.0001$
Farmer knowledge in Dodoma that vaccination against ND can be done by eye-drop administration	47 (47)	84 (86)	$P = 0.0001$
Farmer knowledge in Mtwara of the incubation period of ND	50 (50)	71 (71)	$P = 0.002$

^a Sample size was too small for statistical analysis.

^b NS = not significant

Cost–benefit analysis

In economic terms, the direct cost of ND is considerable. For example, it is estimated that 30–80% of the 27 million village chickens in Tanzania die annually from ND. Village chickens sell for approximately A\$2.70–4.00 per bird. At a 30% mortality rate, the minimum direct annual cost of uncontrolled ND is A\$21,870,000. Table 4 provides an estimate of the direct annual cost of ND in each participating country.

Discussion and conclusions

The survey results for each country show a statistically significant reduction in mortality in vacci-

nating households and an associated increase in flock size. Equally, in each country, an increasing number of farmers is demonstrating willingness to pay community vaccinators to vaccinate their birds. Poor rural families in particular benefit from increased numbers of chickens and eggs: nutrition and food security are improved, and poverty is alleviated through asset accumulation and other means.

In Tanzania, vaccination against ND, using I-2 or other vaccines, had been carried out by some households in a few of the pilot villages before SANDCP commenced. However, these efforts met with limited success and, in many cases, farmers discontinued vaccination. SANDCP commenced in Tanzania in

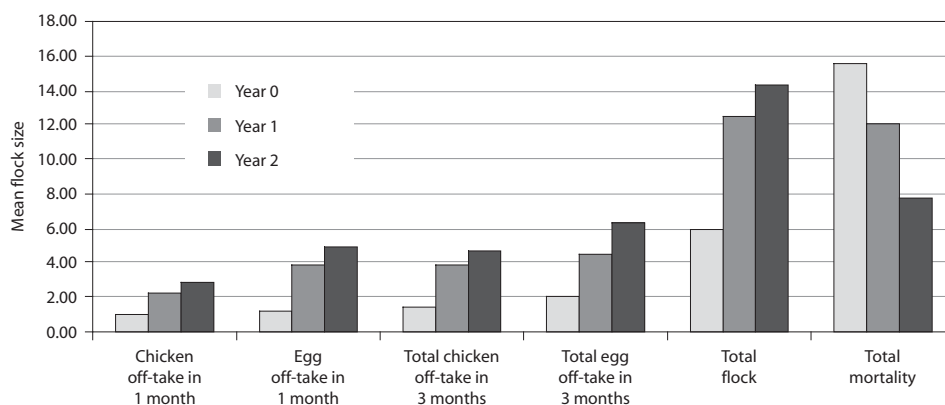


Figure 1. Production, off-take and mortality data in vaccinating villages surveyed in 2003, 2004 and 2005 in Mozambique ($P < 0.01$ between year 0 and 2 in all cases)

Table 3. Comparison of mortalities over the previous 6 months in households vaccinating or not vaccinating against Newcastle disease in Cahora Bassa district of Mozambique

Category	Non-vaccinating		Vaccinating		<i>P</i> value
	<i>n</i>	Mean ± SE	<i>n</i>	Mean ± SE	
Adult mortality divided by flock size	29	2.393 ± 1.048	27	0.360 ± 0.103	$P = 0.023$
Chick mortality divided by flock size	29	2.303 ± 0.578	27	0.256 ± 0.078	$P < 0.001$
Total mortality divided by flock size	29	4.696 ± 1.456	27	0.617 ± 0.163	$P < 0.001$

Table 4. Estimated direct annual costs (in Australian dollars) of uncontrolled Newcastle disease in each participating country, assuming a mortality rate of 30% and a market value of A\$2.70 per bird.

Country	Village chicken population	Minimum direct annual cost of uncontrolled Newcastle disease
Malawi	8,000,000	6,480,000
Mozambique	26,000,000	21,060,000
Tanzania	27,000,000	21,870,000

July 2002 and focused on developing and producing a comprehensive extension package, improving local production and quality control of I-2 vaccine, organising and implementing vaccination campaigns undertaken by government agencies and non-government organisations, and establishing effective cost-recovery mechanisms. The first SANDCP-supported vaccination campaign conducted in collaboration with community vaccinators was carried out in May 2003.

Although SANDCP had been operational in the target villages for only 2 years at the time of the final survey, project interventions resulted in significant changes in the households surveyed. Data showed that vaccination of village chickens against ND, carried out according to project recommendations, led to improved chicken production, measured by significant increases in flock size and off-take, and a significant decrease in mortality. Knowledge about key aspects of ND and its control also improved in the target groups. In vaccinating households, emergency measures, such as forced sale and consumption of birds generally taken prior to an expected ND outbreak to minimise losses, also decreased.

Participation in vaccination campaigns also increased significantly, indicating that farmers recognised the benefits of vaccination and were willing to pay for a reliable, well-organised vaccination service. This finding is supported by the work of Hooten et al. (2003), who showed that households in Mwanza, Tanzania, were willing to pay for ND vaccination at a level that suggested the potential for full cost recovery.

Participation rates and knowledge levels of male and female farmers interviewed were high by the last year of the survey, indicating that the extension and training methodologies adopted by SANDCP

reached both groups effectively. These findings suggest that the goals of improved rural food security and improved livelihoods of the rural poor have been met in the target areas in Mozambique and Tanzania.

Acknowledgments

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Bicycles, T-shirts and boots: community involvement in Newcastle disease vaccination campaigns

Brigitte Bagnol¹

Abstract

Newcastle disease vaccination campaigns in Tanzania and Mozambique within the Southern Africa Newcastle Disease Control Program aimed to promote the involvement of communities in the activities through participatory design, planning, and monitoring and evaluation of the vaccination campaigns. The paper analyses the different issues faced over a period of 3 years in Mozambique and Tanzania to reach this objective. In addition to discussing the barriers to community participation itself, the paper stresses the need to take into consideration the need for community leadership to ensure the success of the campaigns.

Background

Tanzania, together with Malawi and Mozambique, has been involved with the Southern Africa Newcastle Disease Control Project (SANDCP), which promotes the local production and quality control of the I-2 thermotolerant Newcastle disease (ND) vaccine, its administration by community vaccinators and the establishment of effective cost-recovery mechanisms.

This paper reflects on community participation, and specifically on the role played during ND vaccination activities by community leaders and their expectations from this collaboration with extension agents and vaccinators.

Sustainability of vaccination campaigns and their organisation at village level

From the start, one of the challenges to promote three vaccination campaigns per year was to ensure a good collaboration between male and female farmers, vaccinators, agricultural committees, community leaders and extension services. This collaboration should ensure good timing of preparations for the vaccination campaign and efficient organisation of farmers during vaccination. SANDCP wished to establish a sustainable mechanism in which each of the participants had a role to play. During the training of trainers in 2003, before the start of field activities, the roles and responsibilities of each of the key players were discussed and documented.

Important ways in which the activities could be sustained were discussed, and recorded as follows by Sprowles and Bagnol (2003):

- to ensure that the vaccine works
- to involve communities in the planning
- implementing and monitoring of the campaigns

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- to give the communities the chance to participate in decision making about ND control
- to involve women in all aspects of the activity
- to make sure that farmers can organise themselves to either procure and purchase vaccine or, ensure that government agencies can supply it, on time
- in the medium-term farmers should be able to vaccinate their own chickens
- to ensure that vaccine can be produced and sold at a price affordable to farmers
- to ensure that the price allows full cost recovery for production and distribution
- to ensure that adequate compensation is given to vaccinators and motivators at field level to make the awareness raising and vaccinating an economically viable activity
- if a decision is made to sell below cost price, an adequate assessment of the subsidy costs implicit in the decision to cover all costs of production, distribution, advertising and application should be made.

The farmers were to identify families with chickens, to keep money to pay for vaccination, to select vaccinators, and to monitor and evaluate each vaccination campaign. Vaccinators were to receive the vaccine from the extension workers, plan and organise village chicken vaccination with the committee, vaccinate, collect money from farmers, keep records and report on vaccination numbers, and pay the extension agents for the vaccine. Village leaders were to mobilise the community, supervise vaccination activity, and participate in the monitoring and evaluation of the activities. Extension agents were in charge of making vaccine available to vaccinators, coordinating and supervising the vaccination campaigns, and reporting to ward and district superiors. Existing or ad-hoc committees were in charge of creating awareness, supervising vaccinators, monitoring and evaluating vaccination campaigns, and liaising between community and extension workers. In Tanzania, local government at village level promotes the establishment of several committees (water, security, agriculture etc.). In the SANCP area in Mozambique, World Vision was working with development committees integrating health, agricultural and nutrition aspects. It was agreed that all activities should be carried out in collaboration with village government, traditional structures and other stakeholders to ensure the sustainability of the ND campaigns.

Benefits to male and female vaccinators

Ensuring that vaccinators would have adequate compensation and motivation to carry out the vaccination campaigns three times per year was a major priority. After discussion at all levels it was established that the price of the vaccine per bird vaccinated should be TSh30² in Tanzania and MZM500³ in Mozambique. These prices should have allowed the vaccinators, from previous experience, to purchase the vaccine vial and make a small profit for their work.

Various items were distributed to vaccinators to make them more readily identifiable, to give them more prestige and to motivate them. In Mozambique, T-shirts and caps were distributed by the project. World Vision, which was terminating its intervention, decided to distribute bicycles. With World Vision withdrawal, government extension services, which had less access to means of transport than their colleagues, became responsible for continuing the activity. The offer of bicycles was seen as a way to ensure that this occurred, giving vaccinators the mobility to contact extension agents from government, to access the vaccine and to report on their activities.

In Tanzania, SANDCP distributed caps, T-shirts, boots and raincoats.

Questions raised by distribution of various items to vaccinators

Distribution of the aforementioned items has been more discussed than any other issue in the project, from SANDCP leadership to the village level. Distribution of these items raised numerous questions and conflicts at all levels. The quality of the T-shirt, and the illustration and message on it, were issues of debate. Who should receive them? Should the extension workers be included and the district officers? What about the village leaders? How many bicycles, caps and T-shirts should be distributed? What percentage of women benefited from these items? Analysis of their adequacy to women was not assessed.

² In January 2005, the US dollar/Tanzanian shilling (TSh) exchange rate was US\$1 ≈ TSh1,000.

³ In January 2005, the US dollar/Mozambican metical (MZM) exchange rate was US\$1 ≈ MZM19,500.

Discussion around the distribution of the bicycle was even more complex, because a bicycle is really a luxury item in Cahora Basso (Mozambique) and very few people own one. To ensure that the bicycle would be used for vaccination campaigns, they were not given to the male and female vaccinators but to the village as a whole.

To what extent these items helped to solve the problems of access to vaccine, and of coordination and supervision by government extension services and village leaders, needed to be assessed.

Mtwara district experience

The Mtwara district (Tanzania) experience is very important because of the role played by community leaders during the whole SANDCP activity.

In Mtwara district, campaigns have been conducted since 2000 using I-2 vaccine produced by the Animal Disease Research Institute. A few reports (Sprowles and Bagnol 2003; Bagnol 2004a,b) give useful background information on experiences before SANDCP and during the first years.

Detailed information exists commencing with the first vaccination campaign in Mtwara, thus allowing for a great deal of analysis. Bagnol (2004b) showed that, starting from an average of 18% of the total number of households vaccinating in May 2003, the proportion of households vaccinating reached 29.8% in September 2004 following five vaccination campaigns. As data from the questionnaire applied in 2003 and 2004 showed that approximately 50% of households own chickens, this means that around 60% of households owning chickens are vaccinating, implying a very high level of adoption of the vaccination in these villages. Various reasons can be postulated for this:

- chickens are the only animal raised
- deaths of chickens due to ND were not registered after any vaccination even if there were rumours of such
- the decision to vaccinate during three consecutive campaigns in vaccinating households only, to avoid allegations of death of chickens due to vaccination that might be due to other causes
- high numbers of vaccinators
- adequate geographical distribution of vaccinators
- the political will to implement vaccination both at district and village level and involvement of village government
- supervision and use of a data-collection system.

Ten vaccinators selected by the communities received 3 days of training before the May 2003 campaign to work in the five pilot villages all located in Nayamba division: Njengwa, Narunga and Nangawanga in Njengwa ward and Nitekela and Migombani in Nitekela ward (Wegener 2003; Wegener and Ahlers 2003). The vaccinators comprised five women and five men, two from each of the five villages. Twelve extension workers from the district were also trained.

Vaccination activities in Mtwara district were always characterised by intense and enthusiastic discussion both within and outside the project team. Decisions on ways to carry out activities did not always follow the project recommendations and design.

After the first campaign in May 2003, some problems were identified and the district team decided that only households vaccinating during the first campaign would be allowed to vaccinate in subsequent campaigns. This was considered a strategy to ensure survival of chickens and show the efficiency of vaccinations. Although this option was highly criticised (as the number of vaccinating households remained low), vaccination was successful and awareness was raised.

Discussions with local government officials at village level in July–August 2004 showed that they felt excluded from the process, as vaccinators received the vaccine and carried out the activity with little control by local government. The notion that vaccinators were autonomous and that the money collected by them was an ‘income’ was highly criticised. It was decided that, as the activity was made obligatory by district and village government, it should be the responsibility of village government. The activity should be in their plan of work and controlled by them. The vaccine should be given to them and they would then give it to the vaccinators. Similarly, the money should be divided between them: TSh10 should go to the vaccinator, TSh10 to the village government and TSh10 to the district. It was decided that vaccination campaigns should be compulsory (a decision recorded in the written report of the meeting). The philosophy was to vaccinate as many chickens as possible in 3 days (the least time possible). The strategy to vaccinate over 3 days was to make sure that the vaccine was still active and avoid previous problems, as there is no cold chain available in most villages. The vaccination campaign of September 2004 was compul-

sory (by January 2005 local authorities had decided not to make the vaccination compulsory). In May 2004, district government and extension services decided that they should increase the coverage of chickens and households vaccinated.

Discussion of Mtwara experience

All these decisions were taken with a very high degree of autonomy by the district team with little consultation with the country project leader or regional team leader and without taking into account experience from other project areas. In Dodoma (Tanzania), for example, the fee for vaccinators had already been reduced from TSh30 to TSh5 in 2003–04, but the decision had to be reversed to bring back the fee of TSh30 per bird as an appropriate reward to the vaccinator for their activity.

As indicated by the numbers in Table 1, the first three campaigns operated under the rule that only those who vaccinated in the first campaign could engage in successive vaccinations. As a result, the number of households vaccinating remained low. In May 2004, this rule was removed and anyone could vaccinate. As a result, a jump in the number of households vaccinating is evident, from 305 in January 2004 to 700 in May 2004. In September 2004, vaccination was made compulsory, but there was no increase in the number of chickens vaccinated.

The data show a very low level of efficiency of the vaccinator. The number of chickens vaccinated per vaccinator seems very low compared with results from Tete (Mozambique) or Dodoma. In September 2004, an average of 105.5 chickens were vaccinated per vaccinator. The average number of households covered by one vaccinator is also very low, with vaccinators working with an average of 14 households during the September 2004 campaign.

It is worth noting the increase in the average number of chickens owned per household. While the average was 6.0 chickens in May 2003, it had risen to 9.4 chickens in January 2005 (Table 1).

Discussion of the idea of a levy of TSh20 per bird vaccinated

As a result of the success of the vaccination campaign and to establish their control over possible funds from a good information system (vaccinators have the list of households vaccinating and the number of chickens), the village government decided to raise money from the vaccinators. This situation created discontent amongst the vaccinators, as shown by the fall in the number of vaccinators participating in the September 2004 campaign (from 61 vaccinators in May 2004 to 48 vaccinators in September) and also by the fall in number of chickens vaccinated, from 5,553 in July 2004 to 5,062 in September 2004.

The decision to charge the vaccinator TSh20 (TSh10 for the district and TSh10 for the village) for each bird they vaccinate for TSh30 needs to be carefully analysed.

The main justification for this initiative is to create a village-level fund to allow the purchase of vaccine and ensure autonomy and security at village level to continue with vaccination campaigns without depending on money kept by the vaccinators. However, what happens if the vaccinators have not the money to pay for the vaccine before vaccination? Also, what will happen if the farmers do not have money to pay for the vaccine? The idea of the village leaders is to use this fund to create a buffer in case of difficulty. The objective is also to reduce the money received by the vaccinator because there is the feeling that they receive too much for their service.

Table 1. Number of chickens vaccinated. Data from the six campaigns carried out in Mtwara in five Southern Africa Newcastle Disease Control Project pilot villages.

	No. of households involved	No. of chickens vaccinated	Average no. of chickens/ household	No. of vaccinators	No. of chickens/ vaccinator	No. of households/ vaccinator	No. of vials
May 2003	492	2,976	6.0	34	87.5	14	21
September 2003	479	1,995	4.2	39	51.1	12	19
January 2004	305	2,441	8.0	36	67.8	8	20
May 2004	700	5,553	7.9	61	91.0	11	42
September 2004	689	5,062	7.3	48	105.5	14	20
January 2005	584	5,473	9.4	No data	No data	No data	No data

A vial of vaccine costs TSh1,200 at Veterinary Investigation Centre (VIC) level and Tsh2,000 at vaccinator level to ensure that TSh800 per vial is raised for distribution of vaccine from the VIC to the farmer level.

Collecting TSh800 per vial with an average of 20 vials to vaccinate around 5,000 chickens, the district should collect TSh16,000 Tsh (TSH8,000 × 20 vials). Charging TSh20 per bird vaccinated that could bring TSh100,000 (5,000 chickens × TSh20) for the villages in the SANDCP area that they would share within the district.

The idea of creating a fund at village or yard level to ensure the continuity of the ND vaccination campaign is of great interest and shows the importance of the vaccinations. However, this tax and its management can create numerous problems.

There is a part of education that is biased in the project. We want to be trained and informed about the project not only about vaccination... When you give things you give it only to the vaccinators... The role of the government is not well conceived.
(Mtwara, February 2005, leader from Njengwa village who followed the project since its beginning)

When this issue was discussed, village leaders also raised the problem of their own contribution to the vaccination campaign and their non-paid work. This shows the complexity of the problems. The village leaders complained that the vaccinators went to training and received per diems, T-shirts and caps, and when visitors come to the village, they looked for the vaccinators and not for them. They were concerned that they were losing access to resources and power.

On the one hand, village leaders would like a share of the money and the power resulting from the ND vaccination campaign activity. On the other hand, they want to improve the vaccination campaign coverage by making it compulsory. Vaccinators tend to consider that, if their request for TSh20 per bird is unacceptable, without their support this will be impossible. Similarly, vaccinators sometimes need the support of the village leaders to oblige households to pay for vaccinations.

From information collected in February 2005, it seems that neither district authority nor village government managed to raise the TSh20 tax from the vaccinators. Leaders explained that vaccinators avoided leaders and tended to under-report the number of chickens vaccinated. Taxes are often

charged to farmers when selling cashew nuts. For fear of being charged, farmers might also be afraid to report an increase in their income as a result of vaccination against ND when filling in the questionnaires for the annual evaluation of the impact of the project. For the objective of the research, it is worth noting that this under-reporting might have affected the recorded numbers of chickens owned, eaten and sold. Leaders explained that, when a register of the number of animals owned is carried out by government authorities, farmers always under-report their assets as they know that it is related to wealth evaluation and taxation. Another reason for under-reporting the number of chickens during questionnaire completion is the belief, raised by leaders, that there will be a distribution of birds. In January 2004, during a drought, vaccinators reported the absence of payment by farmers. The project paid the vaccinators for doses not paid for by farmers. This situation might lead, according to the leaders, to continuous under-reporting of vaccination payment. But this can also be seen as reflecting the same kind of conflict between leaders and vaccinators as that raised above.

It seems that a taxation system is under discussion in Tanzania, or at least in Mtwara district. For example, as a result of taxing the sale of cashew nuts, the production data collected at local government level went down in the past few years, obliging the authorities to remove such tax that was considered a 'nuisance' by farmers. However, due to decentralisation and local government autonomy to regulate and collect taxes, this kind of tension is quite normal.

In discussion with 25 people (one woman) in Nanyombe in February 2005, representatives of vaccinators and local government from Nitekela and Njengwa assessed the strengths and weaknesses of the project. Availability of an effective vaccine well accepted by farmers and a decrease of chicken mortality were considered as strengths of the project. Another important element considered that the involvement of village leaders in the vaccination process was a strong point. The main weakness identified was that the relationship between vaccinators and village leaders is still not good.

Conclusion

I aimed to give some examples to show the complexity of ND vaccination campaigns. Boots, T-shirts, bicycles, raincoats and money raised by vaccinators from the vaccination of each bird are

impacting in various ways at village level. I am raising these issues to emphasise the crucial role that village leaders play in any activity carried out in villages. I would like to stress that voluntary and disinterested ‘community work’ or ‘participation’ is very often an illusion created by a ‘development culture’ as, in practice, any input or innovation brought into a village is often the object of negotiations and conflicts.

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Managing the risks to vaccine quality associated with the small-scale production of I-2 Newcastle disease vaccine in developing countries

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Abstract

Manufacturers in developing countries involved in the small-scale production of I-2 Newcastle disease (ND) vaccine for use in village chickens face many challenges that can affect vaccine quality. At the laboratory level these include problems in obtaining quality consumables, ensuring reliable and regular supplies of water and electricity, maintaining vital equipment, retaining trained and motivated personnel, and providing an appropriate production environment. Vaccine packaging and distribution in the field can also present problems.

Regulatory authorities in many developing countries have developed good manufacturing practice (GMP) standards to ensure the quality of imported and locally produced pharmaceutical products and vaccines. However, in many cases, local small-scale producers of veterinary vaccines will have some difficulty in meeting these standards. Quality assurance managers must therefore adopt a risk-based approach to GMP and establish controls and procedures that ensure production and distribution of a product of acceptable quality at an affordable price for use in control of ND in village chickens. One such approach drafted by the quality assurance managers of the Southern Africa Newcastle Disease Control Project participating countries is discussed.

Introduction

Successful and sustainable control of Newcastle disease (ND) in village chickens depends on a reliable, readily available and affordable supply of vaccine suited to the needs of village chicken owners. The vaccine used may be an imported product from a large pharmaceutical company, or a local product from a small-scale manufacturer. In

either case, the vaccine should be of a quality acceptable to local regulatory authorities.

Good manufacturing practice (GMP) standards have been developed by international and national regulatory authorities to minimise the risk of distributing poor quality or harmful pharmaceutical products and vaccines. GMP ensures that a product is manufactured in a safe, clean environment, by specified methods, under adequate supervision and with effective quality control procedures. The acceptable level of risk may vary from country to country, from zero-risk (which is very expensive and practically impossible to attain) to a level appropriate to local needs and resources.

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Principles and definitions

Hazards to vaccine quality

Vaccine quality is considered ‘the single most important determinant of vaccination success or failure’ (Mariner 1997). It comprises four essential elements (Soulebot et al. 1997):

- *Safety*—the vaccine will not cause local or systemic reactions when used as recommended by the manufacturer.
- *Potency*—the vaccine contains sufficient virus to induce a protective immune response in vaccinated birds.
- *Efficacy*—the vaccine will protect against local virulent strains of ND virus.
- *Purity*—the vaccine is not contaminated with extraneous pathogens, chemical or physical agents.

Hazards are biological, physical or chemical agents that have the potential to adversely affect vaccine quality, and may occur at any stage during the production, storage, distribution and use of the vaccine.

Risks

Risk is the combination of the probability that a hazard will occur and the severity of the consequences. When determining the risk it is important to consider:

- the characteristics of the target population
- the route by which the hazard gains entry to that population
- the biological, economic and environmental significance of the hazard in the target population.

Risk management

Quality risk management is a systematic process for the assessment, control, communication and

Small-scale production of I-2 ND vaccine is a government mandate in most developing countries. Vaccine production facilities may be purpose-built or may be adapted from rooms within a research or diagnostic unit. Staff may be dedicated to vaccine production or have overlapping responsibilities. There are often problems in obtaining quality consumables, ensuring reliable and regular supplies of water and electricity, maintaining vital equipment, and retaining trained and motivated personnel. Storage and distribution of vaccine in the field face similar problems. These present challenges to local small-scale vaccine manufacturers in their attempts to meet GMP standards (Table 1).

The benefits to be gained by having the product available must be weighed against the costs of attaining and ensuring the standards. The procedures used to attain the standards must ensure low risk in relation to hazards but not be so burdensome that they will prohibit the availability of an effective product at acceptable cost to farmers (OIE 2004). Quality assurance managers supervising manufacture of I-2 ND vaccine in small-scale production facilities must therefore adopt a logical, scientifically sound, risk-based approach to GMP in the manufacture of vaccines.

Quality assurance managers of the three Southern Africa Newcastle Disease Control Project (SANDCP) collaborating countries met to discuss common problems in meeting GMP standards. An approach was formulated that comprises a number of steps: 1. the hazards to vaccine quality are identified, 2. the risk that they will occur at specific points of manufacture and distribution and cause infection and disease in the target population is assessed, and 3. risk management options are identified and implemented. In this way, production and distribution of a vaccine of acceptable quality at an affordable price for use in village chickens is assured.

Table 1. Comparison of large- and small-scale vaccine manufacture

Factor	Large-scale vaccine manufacture	Small-scale vaccine manufacture
Premises	Purpose-built; generally dedicated to manufacture of pharmaceutical products	Generally not purpose-built; often within a diagnostics and research unit
Personnel	Manufacture of pharmaceutical products is their only responsibility	May also have responsibilities in diagnostics and research
Production procedures	Automated	Manual
Batch size	Large	Usually small
Inputs	Easy to access	Difficult to access
Funding	Assured	Unreliable

review of risks to the quality of a pharmaceutical product throughout the product life cycle. The evaluation of risk to vaccine quality should be linked to the protection of the target population and must be based on scientific knowledge.

The approach

There are several tools that can be used to support quality risk management. These provide a practical and scientific approach to decision-making, and transparent, reproducible and well-documented methods to accomplish the steps of the process (EMA 2005). The approach described in this paper is based on 'hazard analysis and critical control points' (HACCP) methods, defined by EMA (2005) as follows:

HACCP is a systematic, proactive and preventive method for assuring product quality. It is a structured approach that applies technical and scientific principles to analyze, evaluate, prevent and control the risk or adverse consequences of hazard(s) due to design, development, production and use of products.

The approach taken by SANDCP quality assurance managers consists of the following stages.

1. Preliminary steps

- (a) A team is assembled to conduct the assessment. The team should consist of personnel with skills in vaccine production, experience in the distribution and field use of the vaccine, and knowledge of the national animal disease situation and the national regulatory requirements for veterinary biological products.
- (b) The product and the methods of production and distribution are described (an example is shown in Annex 1). This may be represented diagrammatically.
- (c) The intended use of the product is described (an example is shown in Annex 2).

2. Hazard analysis

- (a) This step of the approach can be summarised in the question: 'What might go wrong?'
- (b) The hazards that might reasonably be expected to occur at each step of production, storage and distribution of the vaccine up to the point of use are identified and listed. The hazards are grouped into biological, chemical or physical agents.
- (c) The hazards are analysed using criteria agreed by the team, and those that warrant further

consideration are identified. For example, the team may agree that biological hazards warranting more detailed examination must be pathogenic to chickens, have significant biological and socioeconomic consequences, and be subject to national control measures.

3. Risk assessment

The questions that summarise this step are:

'What is the probability that it will go wrong?'

'If it does go wrong, what will the result be? (Consider the biological, socioeconomic and environmental consequences.)'

'How severe or significant will the consequences be?'

- (a) For each of the hazards that warrant further attention, the probability that the hazard will occur is estimated, and
- (b) the severity of any adverse effects is assessed.

4. Risk management

The risk management options should focus on the following questions:

'What is the appropriate level of risk; that is, what is the appropriate balance between the benefits, risks and resources?'

'Is the risk above appropriate levels?'

'What can be done to reduce, control or eliminate the risk?'

For each hazard that needs to be managed:

- (a) the measures needed to reduce the risk to vaccine quality are identified
- (b) the critical points in the production and distribution process for the control of the hazard are agreed
- (c) critical limits for the hazard are established
- (d) a monitoring system is designed and implemented for each of the critical points
- (e) actions needed to deal with any deviations from 'the norm' that may occur are identified
- (f) verification or validation procedures, appropriate documentation and record-keeping are designed and instigated.

Conclusion

The step-wise approach to quality risk management described in this paper is one tool that can be used by quality assurance managers in developing countries to manage the risks to vaccine quality associated with the local small-scale production of veterinary vaccines. It provides a logical, scientifically sound

and proactive way of identifying and controlling potential quality issues and can facilitate better and more informed decision-making. It can also provide national pharmaceutical regulatory authorities with a greater confidence in a manufacturer's ability to deal with potential risks.

The outcome of the approach is a package of controls and procedures that ensures the production and distribution of vaccine of acceptable potency, purity, safety and efficacy at an affordable price for use in the control of ND in village chickens, one of the essential components of a sustainable ND control program (Alders et al. 2001).

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Annex 1

I-2 Newcastle disease vaccine production and distribution

I-2 ND vaccine currently produced in Tanzania is in the liquid form. It consists of allantoic fluid harvested from eggs infected with I-2 ND working seed virus, gelatin in phosphate-buffered saline and small quantities of antibiotics (penicillin, streptomycin and gentamycin). It is packed in plastic dropper bottles.

I-2 ND vaccine is produced under a seed-lot system, ensuring that vaccine is only two passages away from the I-2 ND master seed virus. I-2 ND virus is an avirulent strain of ND virus originating from Australia.

Eggs used for vaccine production come from a commercial hatchery. Records of flock health, production and testing are regularly made available to vaccine production staff.

Aseptic procedures are used throughout production.

Storage in a refrigerator or cold room at 2–8 °C is recommended, but the vaccine will tolerate short periods outside refrigeration (the conditions and times are specified on the vaccine instruction sheet). Vaccine dispatch and transport is best done in insulated containers with frozen icepacks ensuring that the temperature remains below 10 °C until it reaches its destination. In the field, the vaccine dropper may be wrapped in a damp cotton cloth and carried in a covered, open-weave basket. In the vaccinator's home it may be stored in a cool, shady place such as at the base of a clay water pot.

Annex 2

I-2 Newcastle disease vaccine: product description

I-2 ND vaccine is recommended for use in village chicken flocks. These are generally small, multi-age flocks that spend much of their time scavenging. They may be confined during the night to guard against theft. The recommended route of administration of I-2 ND vaccine is by eye-drop.

Evaluation of the cold chain encountered by ‘wet’ I-2 Newcastle disease vaccine from the vaccine production department to the village chicken in Mozambique

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Abstract

Live vaccines are biological products that must be stored away from excess heat, cold or light to ensure maximum potency. The only way to ensure the appropriate conditions for vaccine storage and transport is to have a functional and validated cold chain. However, in developing countries such as Mozambique, maintenance of the cold chain and conservation of vaccines present many challenges. I-2 Newcastle disease (ND) vaccine is ideal for such situations since it can be stored outside refrigeration for short periods, using simple methods that are within the resources of community vaccinators.

The vaccine cold chain encountered by ‘wet’ I-2 ND vaccine in Mozambique was described and evaluated using data loggers. It was found that the cold chain is composed of four major stages, namely 1. Veterinary Research National Institute in Maputo, 2. storage at the Provincial Livestock Services, 3. District Directorate of Agriculture and 4. community vaccinator.

The vaccine cold chain in Mozambique can be divided into the ‘conventional cold chain’ and the ‘non-conventional’ cold chain. The temperatures in the ‘conventional cold chain’ (refrigerators and cold rooms, domestic refrigerators, and insulated boxes with icepacks used for distribution of vaccine) were sometimes outside the recommended range of 2–8 °C. The main factors responsible for this were the poor handling and monitoring procedures, and inappropriate equipment.

The temperatures in the ‘non-conventional cold chain’ (storage of vaccine in a cool place in the home of the community vaccinator, and transport wrapped in a damp cloth in an open-weave basket during vaccination) were below 29 °C, except where synthetic bags were used for vaccine transport.

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Introduction

The Ministry of Agriculture (MINAG) and non-government organisations (NGOs) in Mozambique are committed to control of Newcastle disease (ND) by vaccination. However, vaccination in the village poultry sector is difficult due to high environmental temperatures (often above 30 °C) and poor storage and handling conditions (Nawathe 1988; Bell 2001). Under such conditions, thermotolerant vaccines derived from avirulent Australian strains of ND virus strains V4 and I-2) have proved successful in protecting village chickens against ND (Wambura 2003).

The I-2 ND vaccine was introduced in 1998 by MINAG through the National Veterinary Research Institute (INIVE) in collaboration with the Australian Centre for International Agricultural Research (ACIAR) (Cambaza et al. 2004). In the following year, production began, with the main objective of providing sufficient appropriate-quality ND vaccine for the village poultry sector (R.G. Alders, pers. comm. 2004).

Storage of vaccines in excess heat, cold or light and fluctuating temperature may cause loss of vaccine potency and its failure to provide protection. To solve this problem, it is crucial to maintain the cold chain that links the production, distribution and use of the I-2 ND vaccine in the village poultry sector (Young et al. 2002). This paper evaluates the cold chain encountered by the wet I-2 ND vaccine in Mozambique. The specific objectives were: 1. to describe the cold chain by identifying the equipment used in storage and transport of the wet I-2 ND vaccine; and 2. to evaluate the equipment based on the temperature data recorded.

Materials and methods

The cold chain was described and evaluated during vaccine storage and dispatch at INIVE in Maputo province; during storage and transport at the Provincial Livestock Services (SPP) and District Directorate of Agriculture (DDA), and in the field in the district of Manjacaze in Gaza province in the south; and at the SPP and DDA in the district of Cahora Bassa in Tete province in the centre of Mozambique. The study was conducted during November 2005.

The researcher accompanied all vaccine storage, dispatch and transport procedures, and identified the components of the cold chain by observation. The

temperature was recorded using a Gemini Tinytag data logger⁵ (logger) programmed to record the temperature every minute. The logger was activated and the data downloaded using the Gemini Logger Manager 2.8 (GLM 2.8) software program. The researcher and community vaccinator recorded information relating to the cold chain (date, time, type of equipment and comments) on a form.

The duration of the vaccination campaign was 30 days. At INIVE, the temperature was recorded over a period of 3 days. In Gaza (SPP) the temperature was recorded on two occasions, of 5- and 3-days' duration. In Tete, the temperature was recorded for 14 days. The logger was placed uncovered (close to the vaccine package) in the 'conventional cold chain' (see below) equipment, while in the non-conventional cold chain it was wrapped in damp cotton cloth, as is the vaccine normally wrapped. The environmental temperature was recorded by placing the logger outside the cold-chain equipment.

Results

The pathway of I-2 ND vaccine and logger through the cold chain is shown diagrammatically in Figure 1. The vaccine cold chain in Mozambique can be divided into the 'conventional cold chain' and the 'non-conventional' cold chain.

The conventional cold chain consisted of refrigerators and cold rooms, domestic refrigerators, and insulated boxes with icepacks used for distribution of vaccine. At INIVE, vaccine was stored in refrigerators: two (A and B) were in the Vaccine Production Department, and two others (C and D) were in the Vaccine Sales Unit. Vaccine was also packed and stored in a cool box (E) in the refrigerator. At the SPP in Gaza and Tete, and in the DDA of Manjacaze and Cahora Bassa, vaccine was stored in a domestic refrigerator. During dispatch and transport, vaccine was packed in cardboard boxes (volume 31.5 dm³) lined with Styrofoam insulation sheets (30 mm thickness) with five frozen icepacks ('BLOC-GEL') placed at the sides and in the bottom of the box.

The non-conventional cold chain comprised storage of vaccine in a cool place beside a clay water pot in the homes of five community vaccinators in

⁵ A data logger is a piece of electronic equipment that is used to record data such temperature or humidity at intervals you have set using a computer and software Gemini Logger Manager 2.8 (Young et al. 2002).

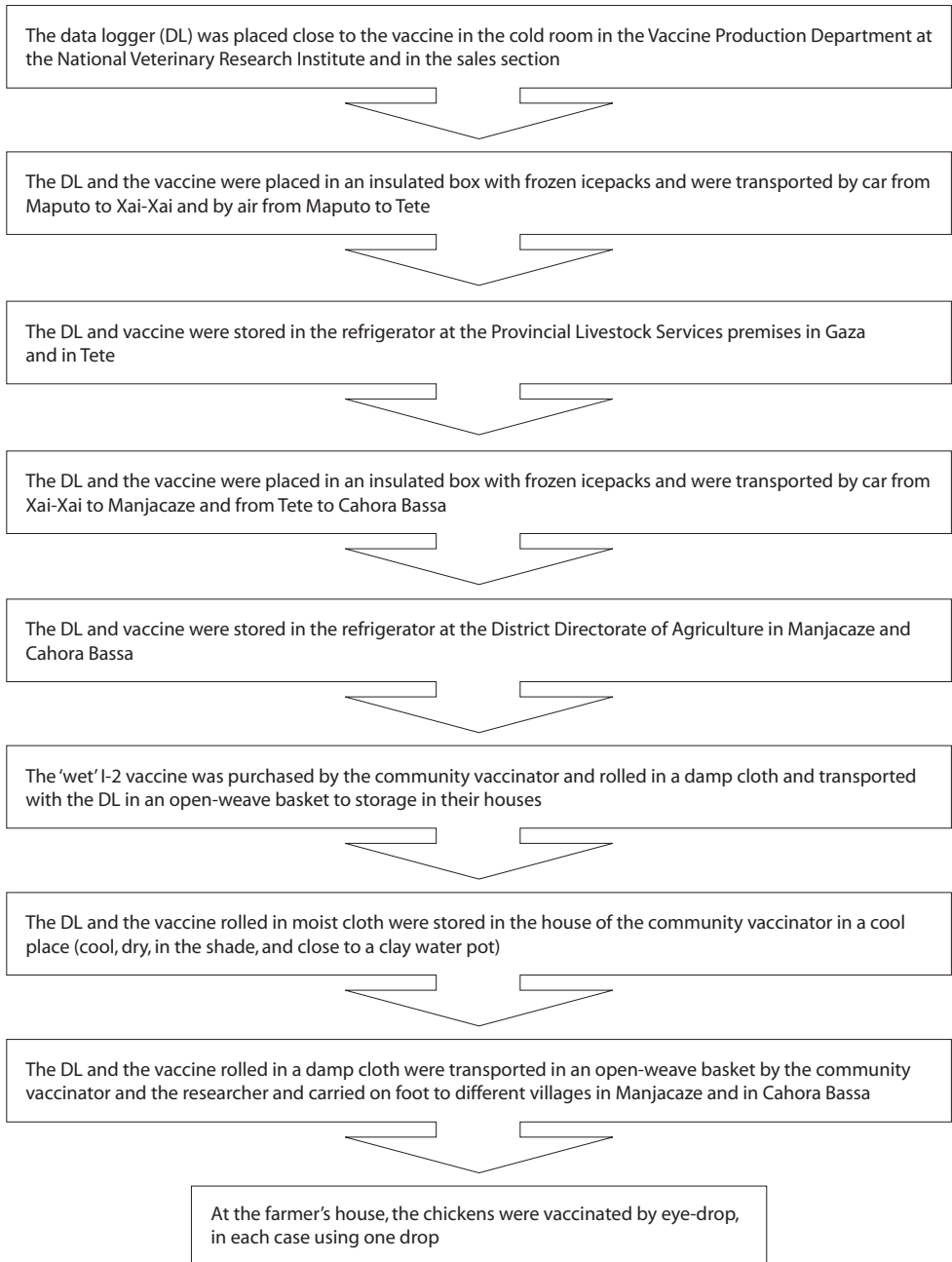


Figure 1. Pathway of I-2 ND wet vaccine and the logger through the cold chain (from the National Veterinary Research Institute, Maputo, to the community vaccinator in Manjacaze and in Cahora Bassa)

Manjacaze and three community vaccinators in Cahora Bassa, and transport of vaccine wrapped in a damp cloth in open-weave baskets during vaccination. It was noted, however, that some community vaccinators used bags of a type that was not recommended.

All the cold rooms at INIVE showed a uniform variation of temperature. The Vaccine Production Department registered temperatures within the recommended range, and fluctuation was minimal. In Vaccine Sales, the fluctuation was greater, and the maximum and minimum values were outside the recommended range (Table 1).

There were power cuts that caused temperature variations in the refrigerator at the SPP. At the DDA in Manjacaze, greater fluctuations were recorded, leading to temperatures that were not uniform. Also, the temperature adjacent to the evaporation plate in the refrigerator was lower than that in the door of the refrigerator.

Higher and non-uniform temperatures were recorded in the insulated box only during transport

from INIVE, Maputo, to SPP at Tete, because non-freeze bricks were used inadvertently. During the transport to DDA at Cahora Bassa, to SPP at Gaza and to DDA at Manjacaze, the temperatures remained within the recommended range for 11 hours of measurement (Table 2).

The refrigerator in the SPP at Tete showed temperatures that were higher than recommended, whereas the refrigerator in the DDA in Cahora Bassa showed non-uniform temperatures ranging from freezing to 8 °C. Freezing is not recommended for storage of vaccine.

Figure 2 shows the conventional and non-conventional stages of the cold chain. In the conventional stage of the cold chain, the temperature was outside the recommended range at the Vaccine Sales Department at INIVE and during the transport to Tete. In all other stages of the cold chain to Gaza, the temperatures were within the recommended range.

Temperatures during the transport and storage of vaccine in the non-conventional stage of the cold chain were within the recommended range.

Table 1. Minimum and maximum temperatures in National Veterinary Research Institute (INIVE) storage and transport equipment

Place	Equipment	Duration (hours)	T (°C)
INIVE: Vaccine Production Department	Refrigerator (A)	72	3.3–5.6
	Refrigerator (B)	72	5.2–8.5
INIVE: Vaccine Sales	Refrigerator (C)	72	8.1–13.5
	Refrigerator (D)	72	8.1–14.2
	Cold box (E)	72	11.5–16.4

Table 2. Temperatures and methods of conservation of I-2 ND vaccine used from dispatch from National Veterinary Research Institute to the District Directorate of Agriculture (DDA) in Manjacaze and in Cahora Bassa

Place	Method	T (°C)	Duration (hours)
Maputo to Gaza	Cool boxes	6.4–8.7	10
Gaza Provincial Livestock Services (SPP)	Domestic refrigerator	8.0–11.1	72
	Domestic refrigerator	4.8–9.5	72
Gaza to Manjacaze	Cool boxes	5.0–10.0	10
Manjacaze DDA	Domestic refrigerator	7.7–15.3	72
	Domestic refrigerator	5.1–10.6	72
Maputo to Tete	Cool boxes ^a	21.6–25.0	5
Tete SPP	Domestic refrigerator	12.6–19.4	144
Tete to Cahora Bassa	Cool boxes	5.0–9.0	11
Cahora Bassa DDA	Domestic refrigerator	0.1–8.2	48

^a With five icepacks

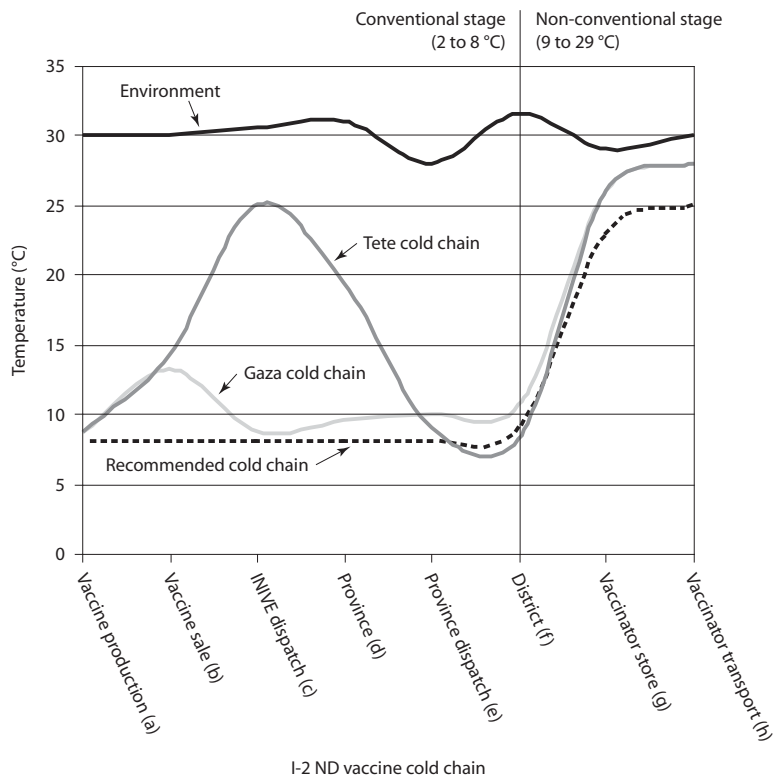


Figure 2. Maximum temperatures in the cold chain from Maputo (National Veterinary Research Institute) to Gaza and Tete (Provincial Livestock Services, District Directorate of Agriculture and village poultry sector): (a) and (b) refrigerator in INIVE, (c) and (e) cool boxes with icepacks, (d) and (f) domestic refrigerator in SPP and DDA, (g) beside a clay water pot, (h) open-weave basket.

The community vaccinator stayed with the I-2 ND vaccine for between 24 and 72 hours. In the open-weave basket with a damp cotton cloth, and in the cool place beside a clay water pot, the temperature remained within the recommended range for 4 and 13 hours, respectively (Table 3). During storage in synthetic bags, however, temperatures were above 29 °C and so they are not recommended for vaccine transport.

Discussion

Vaccines are biological products that are sensitive to excess heat, cold or light. Many vaccines lose potency if stored above 22–25 °C (Nayda et al. 2001) or below 0 °C (Hedenström and Kahler 1992).

The degree of loss of potency is specific to the type of the antigen (virus or bacterium, live or inactivated), and depends also on the solvent, the types of preservatives, stabilisers and protectants used, and whether it is lyophilised or in liquid form (Hedenström and Kahler 1992). In general, the ideal temperature range for storage and transport of vaccine is 2–8 °C (Allan et al. 1978; WHO/EPI 1997). During the preparation for vaccination campaigns, the slogan should be ‘Maintain the vaccine refrigerated and maintain the vaccine’ (Nawathe 1988).

In both rural zones included in this study, the conventional cold chain is deficient at headquarters in DDA and non-existent in the villages. This situation is seen in the whole of Mozambique. Many factors can contribute to poor cold-chain mainte-

nance: inappropriate refrigerators for vaccine conservation, poor monitoring, overfilling the refrigerator, deficiencies in electrical supply and problems with the capacity and knowledge of the personnel (Allan et al. 1978; Hunter 1997; Nayda et al. 2001; Young et al. 2002). Factors that can affect the transport of vaccine in insulated containers include the number, distribution and the physical state of the icepacks, the volume and properties of the insulated container, the number of times it is opened and the duration of opening, and the ambient temperature (Young et al. 2002).

Table 3. Temperature and the method of conservation of I-2 ND vaccine used by community vaccinators

Method	T (°C)	Duration (hours)
Open-weave basket	24.8–27.5	4
Open-weave basket	26.2–28.4	2
Close-weave basket	28.5–31.9	4
Open-weave basket	23.8–28.3	10
Open-weave basket	23.8–29.4	10
Beside a clay water pot	23.6–29.5	13
Beside a clay water pot	26.7–31.1	13
Beside a clay water pot	23.5–27.0	28
Beside a clay water pot	23.3–28.2	12
Synthetic bag	32.0–35.0	3
Synthetic bag	27.5–31.2	8
Leather bag	29.5–33.5	4

In Mozambique, MADER/SANDCP (2003) recommend that community vaccinators store I-2 ND vaccine rolled in moist cloth in a cool shady place beside a clay water pot and transport it in an open-weave basket in the field. In this study, the temperatures recorded during transport and storage of vaccine by community vaccinators showed that the open-weave basket and the moist cloth allow evaporative cooling and a consequent reduction in temperature to values between 23 °C and 27 °C for an average of 4 hours, as was observed by MADER/SANDCP (2003), while storage in a cool place near a pot with cool water also maintained the same temperature range for an average of 13 hours.

It is recognised that many provincial, district and rural zones of developing countries do not have reliable electricity supplies, appropriate vaccine refrigerators and ready access to cooler boxes and icepacks (Spradbrow 1993/94). Under these conditions, heat-tolerant vaccines are recommended, such

as liquid or lyophilised I-2 ND vaccine (Young et al. 2002), NDHR-V4 (Alders and Spradbrow 2001), ITA-NEW (LAPROVET no date) and Newcavac (Bell 2001).

Recommendations

- Ensure that every person in the cold chain (vaccine producers and distributors, and community vaccinators) understands the need for maintaining the cold chain and their role in ensuring this.
- If using a domestic refrigerator for vaccine storage:
 - Use ‘frost free’ or ‘chest’ refrigerators for storage of vaccine. Cyclic type domestic refrigerators are not recommended because they produce wide fluctuations in internal temperatures, with regular internal heating.
 - Store vaccines only in the middle and upper shelves in the refrigerator, to prevent freezing and fluctuating temperatures.
 - Do not overfill the refrigerator; allow good air circulation.
 - Place plastic bottles containing frozen salt water in the refrigerator doors.
 - Open the door only when required and close it as soon as possible.
- Calibrate refrigerators and cold rooms used for storing vaccine and place thermal barriers on the door to reduce fluctuating temperature.
- Ensure that there is good air circulation on all sides of the refrigerator and place it out of direct sunlight. The gap between the rear of cabinet and the wall should be at least 10 cm.
- Check and record the minimum and maximum temperature in the refrigerators daily.
- Ensure that the refrigerator cannot be accidentally unplugged or turned off. Place tape over the power plug and over the switch, to prevent accidental disconnection.
- Store the vaccines in a cool box with frozen icepacks if a dedicated vaccine refrigerator is not available.
- Use frozen ice packs for vaccine transport but do not place vaccine in direct contact with frozen icepacks.
- Wrap the vaccine in a damp cloth and carry it in an open-weave basket in the field. Provide the baskets to the community vaccinators during their training.

- If it is doubted that the vaccine was stored and transported under recommended conditions, check its titre before use.

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The role of local institutions in achieving sustainable Newcastle disease control in village chickens: the experience in Mtwara district, Tanzania

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Abstract

Village chickens, which are widely kept in the rural areas, are one of the most important but neglected sectors in poor rural areas of the southern zone of Tanzania. The industry involves many people, including the most disadvantaged in the community, such as women and children. Rural chickens can be increased more rapidly than any other animals and therefore offer an opportunity for faster cash-income earnings and hence an accelerated rate of development, notably in poor households including female-headed households.

It is stressed that the rural chicken should not be judged by the number of eggs it produces per year but by its ability to add value; that is, adding value to an egg through brooding, hatching and rearing to the grower stage. Many studies indicate that, taking advantage of these unique attributes of local chickens, a household with 5–10 parent stock stands to generate an income of about TSh300,000–600,000 per year (about US\$300–600). Thus, developing the rural poultry industry, starting with Newcastle disease control in rural areas, will benefit most of the rural population, assisting in poverty alleviation as well as improving food security at household level.

To make control of Newcastle disease at village level a concern and priority to everybody, a system has been tested to ensure that vaccination campaigns achieve about 70–80% coverage within the biosecurity zone. This was accomplished through a well-established vaccine delivery pathway reaching to the grassroots, including a sustainable funding system at village level.

Working relationships among rural development stakeholders such as vaccinators, local leaders, non-government organisations, field extension workers and other local institutions in the districts have been well defined and coordinated. To make this happen, all stakeholders in rural development were sensitised to the importance of rural poultry keeping as a viable and reliable resource in poverty alleviation, food security and HIV/AIDS mitigation.

This paper reports the progress made in Mtwara Rural District after the adoption of community-based mass-vaccination programs, as advocated by the Southern Africa Newcastle Disease Control Project.

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Introduction

The rural poultry industry is one of the biggest untapped economic resources in rural areas. It is increasingly evident that, if rural poultry were recognised, developed and incorporated into development plans at all levels, they would contribute greatly to speeding up human development, especially among resource-poor households in rural areas.

Since 1994, efforts have been made to get alternatives to thermolabile Newcastle disease (ND) vaccines into the zone. Initially, trials with thermo-tolerant V4 vaccine were carried out in Nanyamba and Ntekele villages of Mtwara district. Preliminary results were encouraging. With the help of the Tanzania Agricultural Research Project II, the Animal Diseases Research Institute (ADRI) developed a national project to test the immunogenicity of another thermotolerant vaccine (I-2), and determine its ability to protect chickens under village conditions. In the southern zone, the Veterinary Investigation Centre Mtwara, using a protocol developed by ADRI, conducted trials in Mtwara district and Masasi. The results of the trials in the study area indicated that the vaccine was potent, immunogenic and protective for a period of 3–4 months.

After the successful development of user-friendly I-2 ND vaccine for rural areas, it was decided to bring together stakeholders involved in rural development at all levels (division, district and region) to inform them of the advances that have been made in the field of ND control and its link to poverty alleviation and food security. The ultimate goal of these workshops was to sensitise all stakeholders to the importance of rural chickens, to the extent that rural chickens are being considered in any development plans.

Since the importance of local chicken in the production of human food and income generation is frequently overlooked by leaders and most of the promoters of rural development, there is a call for efforts to be made to change the mindset of a large number of stakeholders of rural development. By so doing, stakeholders can realise that rural chickens are a reliable and viable enterprise. As a result, rural chickens will more likely be incorporated into rural development plans.

It is stressed the rural chicken should not be judged by the number of eggs produced per year but by its ability to add value; that is, by adding value to

an egg through brooding, hatching and rearing to the grower stage. Many studies indicate that a household with 5–10 parent stock stands to generate an income of about TSh300,000–600,000² per year. An egg valued at TSh100 can, through brooding, hatching and rearing to the grower be sold at a minimum price of TSh2,000 within 4–6 months. It is important to note that these assets are traditionally owned by most of the rural population, including the most marginalised groups (women, the aged, youths and children).

Statement of the problem

The rural poultry industry has either been neglected or given very low priority by virtually all levels of local institutions, livestock establishments and rural development agencies, including non-government organisations (NGOs). Furthermore, most decision-makers (politicians, planners and even livestock establishment personnel) who are not sensitised to the importance and potential of rural poultry are not aware of the link between low-input rural chicken keeping and the economic gains that may be realised. At the household level, chicken raising brings short-cycle income generation, enhanced purchasing power, increased consumption of animal protein and healthier children. Due to lack of interest in, and extension support for, the village chicken systems, more emphasis is directed at large animal production and especially on cattle rearing.

The distribution system for the thermostable I-2 vaccine, which still requires cold storage, is poor. There is no effective cost-recovery system for vaccines administered to livestock in the family sector.

Facts about rural poultry

- *Rural chickens can be increased more rapidly than any other animals.* They therefore offer an opportunity for faster cash-income earnings and hence an accelerated rate of development, notably in poor households, including female-headed households. If farmers vaccinate at appropriate times, they see a substantial reduction in losses due to ND, increased production, and they will be more receptive to other messages aimed at

² The approximate exchange rate is 1,000 Tanzanian shillings (TSh) = US\$1.00.

improving production. More birds would be available for home consumption or for sale.

- *The rural chicken is well placed to provide essential nutrients for HIV/AIDS-affected people, including self-supporting children and older people.* This important aspect should never be overlooked. Rural poultry are also well placed to meet the needs of disadvantaged rural communities, in particular those carrying the burden of care of families devastated by HIV/AIDS.
- *Currently, ND is causing heavy losses that affect both the nutrition and income of farm families.* It is an irony that this disaster is unrecognised. However, it is influenced by the fact that the assets affected are traditionally owned mostly by the rural population, including its most marginalised groups (women, the aged, youth and children).

Efforts made so far

To date, the following efforts have been made:

- informing the community of the existence of I-2 vaccine, which is appropriate in the fight against ND under village conditions, using village governments and other community institutions
- sensitisation of stakeholders in rural development on the importance of rural poultry keeping as a viable and reliable resource in poverty alleviation, food security and HIV/AIDS mitigation, by conducting targeted sensitisation workshops at regional, district, divisional and village levels
- discussions and open dialogue among stakeholders, such as farmers, NGOs, planners, technical staff and political leaders, to generate ideas that assist the formation of a body that will coordinate, regulate or standardise methods used for local chicken improvement in areas of operation in the zone.

The main objectives of the workshops conducted were:

- to sensitise and draw the attention of all involved in rural livelihood improvement to the role of the local chicken as a resource and an opportunity for rural development and HIV/AIDS mitigation
- to demonstrate to participants and the general public the qualities, economics and importance of local chickens in the fight against poverty and household food insecurity

- to inform participants that ND control by mass vaccination is an entry point and an obvious opportunity to increase numbers of chickens available for sale
- to stimulate exchange of ideas among stakeholders.

Outcomes

Southern Africa Newcastle Disease Control Project (SANDCP) activities in Mtwara district have led to the following outcomes:

- Due to strengthened capability of and stronger relationships between stakeholders, they are better able to successfully implement ND control programs at village level.
- Discussion of matters bearing on rural chicken raising is now a permanent agenda item at all meetings at various levels in Mtwara district.
- Rural poultry development is now being considered or included in development plans at all levels, especially at ward and village levels.
- Rural chicken development funds are being established as a credit facility for poultry inputs, including vaccine purchase, in many village governments.
- Vaccine committees are being formed in all government organisations down to subvillage level.
- Vaccination against ND is considered compulsory, and is done in mass vaccination campaigns conducted during January, May and September every year.

Critical reflection, limitations and the way forward

The key lesson learnt during the implementation of ND control exercises in Mtwara was that, although thermotolerant vaccines are an excellent weapon in the fight against ND under village conditions, much has yet to be done in the following areas.

1. *The rural poultry resource has yet to be recognised by development planners and decision-makers as a viable and reliable source of income to both farmers and authorities.* Efforts should be made to change the perception that rural chicken keeping is an inferior enterprise, and this must be done at all levels. Rural chickens should be high on the agenda of any meetings dealing with rural development. Rural chickens should receive appropriate

attention in budgets and also be considered as a source of income or revenue in terms of taxes.

2. *Extension services and technical support infrastructures for rural poultry keeping are poorly developed.* Rural poultry require grassroots extension networks of a holistic nature. Livestock extension services and technical support centres are inaccessible to most rural farmers. At times, it is uneconomic for technical support personnel to visit scattered farmers with few chickens. On the other hand, districts have few livestock extension staff and they are frequently ill-equipped. This also contributes to extension and technical service delivery breakdown in rural areas. Community participation is of great importance. Schools could be used as demonstration and learning centres for rural poultry keepers. In that way, the size of the gap between farmers and established livestock infrastructures will be minimised.
3. *Inadequate extension and technical support to rural poultry production and health care at village level.* This factor contributes to widespread disease and to excessive production losses and reproductive wastage every year. Furthermore, it was noted that no extension messages were being offered to rural poultry farmers, except advice to shift from local chickens to so-called improved chickens. This propensity of the livestock establishment to over-emphasise exotic breeds was said to be responsible for creating the existing gap between extension staff and farmers who view their local chickens as the most appropriate for the complex circumstances they live in.

Conclusion

Sustainable rural development requires an integrated approach that involves all the key players in development, starting from the grassroots level in the villages to the district level. Village governments and other stakeholders such as NGOs, training institutions and other local institutions need to be fully involved and sensitised for sustainable development to occur. Development of the village chicken resource, which has proven successful in Mtwara, should have a high priority. Other important key players to foster sustainable rural development are the decision-makers, politicians, planners and professionals such as animal health delivery people, vaccinators, extension workers and input suppliers.

Involvement of the important key players, and improvement of animal health delivery services up to the village and ward level, will contribute significantly to the success of the projects. Local village chickens can improve the livelihood of impoverished rural populations by using cheap and readily available resources such as crop residues.

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Reviewing the current curricula relating to diseases and production of chickens, with a view to increasing the importance of village chicken production in Tanzania

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Abstract

Village chickens are the most common type of livestock kept in rural areas of Tanzania, and are kept by even the very poor households. About 72% of rural households keep chickens, and the estimated village chicken population is 26.6 million. Increased village chicken production can significantly improve the living conditions of many rural families through providing valuable nutrition and income through the sale of surplus chickens or eggs.

Unfortunately, this valuable resource is often underrated. There are several reasons for this. Farmers always mention diseases, in particular Newcastle disease, as the major constraint to rural chicken development. When outbreaks occur there are usually high mortality rates and this discourages farmers from investing much time or money in their flocks. Other reasons include the emphasis that government and donor programs often place on commercial (foreign and improved breeds) chickens, and lack of knowledge and skills in village chicken production among smallholder farmers, extension officers, researchers, academics and policymakers. The lack of knowledge is attributed mainly to a dearth of topics related to village chickens in the various curricula of the education system ranging from primary schools, secondary schools and tertiary colleges to the university.

Under the auspices of the Southern Africa Newcastle Disease Control Project, a curriculum review task force was formed to review the current curricula relating to diseases and production of chickens, with a view to increasing the importance of village chicken production. The task force formulated appropriate curricula to be used at different levels (primary schools, farmer training centres, livestock training institutes, Ministry of Agriculture training institutes and universities) and prepared recommendations to the

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ministries. Syllabi for certificate and diploma courses on poultry production, including village poultry, to be conducted by the Open University of Tanzania were specifically formulated to cater for those who cannot attend full-time residential university or institute courses. This paper describes the progress made during the curricula review process and the lessons learnt.

Introduction

Up-to-date statistics on the poultry population in Tanzania are not available but the total number is estimated to be 30,900,000.¹⁰ Of this number, 26,400,000 are local village chickens kept predominantly in the rural areas. Commercial birds, including broiler and layer chickens, are estimated to number about 3,200,000 at any one time, or a total annual turnover of 20 million. There are 1,200,000 ducks and geese, 90,000 turkeys and 40,000 guinea-fowl. Other types of poultry kept include pigeons. It is estimated that, of 3,700,000 total agricultural households, the majority (68% or 2,500,000 households) keep chickens, compared with 1,100,000, 1,300,000 and 520,000 that keep cattle, goats and sheep, respectively.

Of all the livestock kept in Tanzania, local chickens are the most widely and evenly distributed throughout the country (Boki 2000). However, a large portion of the national total is found in the Lake Zone and Southern Highlands, and especially in Mbeya, Shinyanga and Iringa. In southern regions, particularly around Mtwara, the village chicken as a commodity is valued more highly than anywhere else in the country, due to low numbers or total absence of other livestock. The population of rural chickens fluctuates widely from season to season, due mainly to the periodic occurrence of Newcastle disease (ND). Other losses result from predators and poor management.

The major farmyard management system is free-ranging (scavenging), with small shelters provided for the night. The traditional poultry husbandry system has several advantages with respect to meeting the increasing demand for food in the rural areas:

- There are no religious objections to the consumption of poultry.

- Both poultry meat and eggs contain protein of a high biological value.
- Women and children are often in charge of the farmyard poultry. This provides them with a (part-time) job opportunity and source of income. Also, the village chickens form an important source of protein for women and children.
- The production of poultry is a relatively efficient and fast way to turn raw and waste materials into valuable animal protein; poultry have a high feed-conversion compared to other livestock.
- No cold chain is needed; the birds can be bought live.
- Poultry manure is a very efficient fertiliser.
- Farmers are, in principle, more willing to sell poultry and their products rather than larger livestock. Poultry represent a regular cash flow, whereas ruminants represent more of a capital reserve.

Local chickens in Tanzania are used in a number of ways:

- They are used to meet the expenses of attending a traditional healer. In such cases, only black, red or white coloured chickens may be used.
- Some tribes employ parts of the chicken, often mixed with medicinal plants, as traditional therapy against human diseases, particularly childhood illnesses, female infertility, abnormally prolonged menstrual periods and simple fractures.
- Local chickens play an important role in the social life in villages and are used during ceremonies and rituals, in traditional healing and as gifts to respected guests.

The rural chicken supplies about 13–20% of the urban requirement for meat and eggs, and 100% of the rural demand (Minga et al. 1996; Boki 2000). Annual per-capita consumption of chicken products in Tanzania is very low at 1.07 kg of meat and 9.4 eggs. It is generally accepted that the taste of the village chicken is superior to that of the commercial broiler and layer, and it therefore fetches a higher market price. Large markets for rural chickens are found in urban centres. In order to exploit urban

¹⁰ Ministry of Agriculture and Cooperatives, National Sample Census of Agriculture, 1994.95 Report, Volume II.

markets, traders transport live local birds for long distances from centres of production in central zones (Dodoma and Singida) to centres of consumption, particularly Dar es Salaam, using large wicker baskets on trucks and on the rooftops of buses. The Singida region is probably the only area where local chicken keeping has assumed a serious business outlook.

There is no doubt that rural chickens make a big contribution to household income and nutrition. Comparatively little research has been published on village poultry, despite the fact that they are more numerous than commercially kept poultry in many developing countries. Around 80% of the households in rural and peri-urban areas in developing countries keep chickens in their 'backyard' (Branckaert 1996). Family poultry production has an enormous potential to meet the basic protein requirements of people in the developing countries.

The curriculum review process

The curriculum review workshop

During a two-day workshop sponsored by the Southern Africa Newcastle Disease Control Project (SANDCP) the need for curriculum review at all levels was discussed by representatives from: the ministries of Water and Livestock Development (MWLD) and Education; Sokoine University of Agriculture (SUA); the Open University of Tanzania (OUT); the Livestock Training Institute (LITI), Morogoro; the Animal Diseases Research Institute (ADRI); veterinary investigation centres, district councils and the extension service and SANDCP. Workshop participants made the following recommendations:

On university courses

- The content of university courses dealing with poultry should be revised to include more detailed aspects of village poultry. Elements in the course that need revision include:
 - animal science courses: housing; feeds and feeding; breeds and breeding; marketing
 - veterinary courses: important diseases; disease treatment; reporting and diagnosis
 - management and control of disease outbreaks.
- An elective course on family poultry should be initiated. University curricula are constrained by time; hence it is difficult to accommodate a new

course in family poultry at the core level. However, an elective course would be feasible (see below for suggested course outline).

- Further research on village poultry by researchers and students should be encouraged.
- Areas should be established within the university for practical work relating to village chickens.

On diplomas and certificates

- The current syllabuses for certificate and diploma courses should be expanded to include more aspects relating to village poultry. This would involve an extra 12 hours of theory and practical for both courses (see below for suggested changes).
- A recommendation should be sent to the Ministry of Livestock Development asking that it review the decision to discontinue the Diploma in Poultry Production, due to the increasing importance given to poultry production in Tanzania.

On courses and modules

Primary schools

- A village chicken production subject should be included in the vocational skills/agriculture module at Standard 4 or 5 through to Standard 7.
- A training module for teachers and extension officers should be developed in relation to this subject.
- Extension services should promote the value of chicken production to schools to encourage them to select this as one of the three topics they are required to select. Pupils are required to select three topics from carpentry, crop farming, painting, sewing, livestock farming etc.
- The revival of school farms should be promoted to the Ministry of Education; district councils could also be lobbied.

Farmers and associations

- A subject on village chicken production should be included as part of the current module of Integrated Community-based Adult Education.
- This subject could be taught at village level or as a residential course at LITIs.

Extension workers

- A refresher course on village chicken production, health and extension for extension staff at various levels should be introduced, to be held at LITIs and Ministry of Agriculture Training Institutes (MATIs).

Veterinarians and animal scientists

- Introduce refresher courses on village chicken production and health as demand-driven courses offered by OUT and SUA.

The Curriculum Review Task Force

A task force was appointed to progress the recommendations of the curriculum review workshop. Task force members were drawn from the MWLD and the Ministry of Education, SUA, OUT, the LITIs, ADRI, veterinary investigation centres, district councils and SANDCP. Working on the recommendations of the workshop, the task force reviewed the current curricula for poultry production in detail and drafted different course modules for different target groups (see appendix) that included all aspects of free-range poultry production and health.

In order to accomplish these tasks the task force held a series of workshops in the period March 2004 – May 2005. Task force members were divided into three groups:

- Group 1: University curricula in relation to village chickens
- Group 2: Certificate and diploma courses in relation to village chickens (LITIs)
- Group 3: Courses and modules for veterinarians, primary schools, extension staff and farmers.

The course modules for the different target groups are shown in the appendix.

Conclusion

The syllabi for diploma and certificate courses in family poultry and the modules for the different

courses have been finalised by the task force and are ready for submission to the relevant authorities for their comments and for eventual implementation. The syllabi for certificate and diploma courses at OUT have been completed, and preparation of distance-learning materials for students is progressing. The diploma course is expected to start in 2006. The course content is the subject of another paper to be presented at this conference (Minga 2009).

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APPENDIX

Structure of the course modules drafted by the Curriculum Review Task Force for different target groups

Elective course on family poultry at university level

Course structure:

A two credit hour course (1 credit hour = 30 lecture hours or 60 practical/seminar hours) divided between:

- (a) Theory 45 hours
- (b) Practical 30 hours

Course objective:

To equip students with the skills needed to address various challenges related to family poultry management, production and marketing so that the potential of family poultry is fully exploited.

Course contents:

Theory

- The role of family poultry in Tanzania including issues on gender, economy and culture; poultry species considered under family poultry; biology of the different poultry species; breeds and breeding including genetic improvement; and management systems including housing, feeding and feed resource base.
- Poultry diseases including species interactions, aetiology, pathogenesis, diagnosis, treatment and control with emphasis on vaccination; disease reporting, records and record keeping including aspects of type of records, importance of records and how to record; and incubation, brooding and rearing.
- Extension services and family poultry, including extension skills, working with village chicken farmers, planning and conducting extension activities; marketing and marketing systems including grading and packaging; and poultry products processing (edible and non-edible).

Practical

- Practical aspects of family poultry including poultry species, breeds, housing, disease management, marketing, records and record keeping, family poultry extension services. Emphasis shall be laid on farm visits and on-site practical work.

Syllabus amendment for certificate and diploma courses (LITIs)

Subject: Poultry production

- 1.0 Introduction:
Include the role and uses of village chickens (certificate and diploma courses).
- 2.0 Breeds and classes:
Include types of village chickens
- 3.0 Planning of poultry farms:
Include types of poultry to be kept (village chickens)
Add practical hours for site selection (3 hours)
- 4.0 Systems of poultry production:
Put more emphasis on commonly used systems in Tanzania, i.e. semi-intensive, deep litter and free-range
Include advantages and disadvantages of improving local chickens through cross-breeding (certificate and diploma courses)
- 5.0 Incubation and hatching:
Include advantages and disadvantages of using broody village chickens
Put more emphasis on using local brooders in rearing of chicks
- 6.0 Hatchery hygiene:
No changes
- 7.0 Management of chicks from 0–8 weeks:
vaccination of chicks, with more emphasis on village chickens
Include vaccination methods, types of vaccines, organisation of vaccination program and campaigns for certificate courses

Include reporting of disease outbreaks (certificate courses)

Include selective feeding of village chickens according to age group and seasonality

Include the importance of supplementation of village chickens

8.0 Management of growers:

Include supplementation of village chickens

9.0 Management of layers:

Include scavenging feed resources (certificate and diploma courses).

Add more hours for practical (3 hours)

10.0 Management of table birds:

No changes

11.0 Poultry housing and equipment:

Include housing for village chicken using locally available materials (certificate and diploma courses)

Add more practical hours (3 hours)

12.0 Poultry process and marketing:

Include organisation of marketing of village chickens (certificate courses)

13.0 Record keeping:

Include marking of eggs for identification, recording and incubation

Include data collection analysis and interpretation (certificate courses)

Include data processing (diploma courses)

Add more practical hours (3 hours)

14.0 Diseases:

Put more emphasis on interaction of various diseases (diploma and certificate courses)

Include field diagnosis of various diseases

Include reporting of livestock disease outbreaks

Suggested topics for courses and modules

A. Module for primary schools

Module: As part of the module ‘Vocational skills/ agriculture’

Subject: Village chicken production

Topics:

- Types of chicken production systems
- Role and uses of village chickens
- Types of local chickens in the locality
- Husbandry, housing and nutrition
- Diseases and parasites of economic importance in the locality—types, recognition, control

- Record keeping

Level: Standards 5 to 7; theory 15 hours, practical 15 hours, total 30 hours

Responsible person: teachers and training officers, Ministry of Education

B. Module for farmers

Module: ‘Integrated community-based adult education’

Subject: Village chicken production

Topics

- All topics covered for primary schools, plus the following:
- Routine vaccination and vaccination techniques
- Drugs and vaccines—use, type, handling, transportation, and application
- Reporting disease outbreaks
- Marketing systems for eggs and chickens

Level: Farmer groups and associations

Duration: 20 hours theory and 20 hours practical

Responsibility: Extension officers

C. Refresher module for extension workers

Module: ‘Refresher course on village chicken production’

Subject: Production, health and extension

Topics:

- Poultry extension
- Organising vaccination programs and campaigns
- Reporting disease outbreaks
- Drugs and vaccines—type, use, handling and application
- Participatory monitoring and evaluation of field activities
- Record keeping
- Post-mortems and specimen collection
- Field diagnosis of diseases
- Scavenging feed resource base
- Marketing systems
- Poultry husbandry

Level: Certificate and diploma holders

Duration: 30 hours theory and 50 hours practical = 80 hours total

Responsibility: [undecided]

This course could be done in a way that it also trains the extension officers for the farmer and primary school courses and gives them the materials and knowledge to conduct these courses.

D. Refresher module for veterinarians

Module: 'Refresher course on village chicken production and health'

Subject: Village chicken production, health and extension

I. Production topics:

- Systems of chicken production
- Importance of village chicken production
- Breeds
- Genetic improvement
- Husbandry, housing and nutrition
- Scavenging feed resource base

II. Chicken health topics

- Chicken biology and anatomy
- Diseases and parasites
- Post-mortem and specimen collection
- Field diagnosis of diseases
- Reporting disease outbreaks

III. Extension topics

- Extension skills; adult education
- Gender aspects
- Religious and cultural aspects
- Working with village chicken farmers
- Planning and conducting extension activities
- Participatory monitoring and evaluation

Duration: 20 hours theory and 20 hours practical = 40 hours total

Sokoine University of Agriculture

SUA offers poultry production and management courses to both undergraduate and postgraduate students:

Undergraduate

- BSc Animal Science, 25 hours (lectures), 15 hours (practical) (40 hours)
- BVM, 20 hours (theory), 15 hours (practical) (35 hours)
- BSc Agriculture, 10 hours (theory and practical)

Postgraduate

- MSc Tropical Animal Production, 40 hours

Subjects relating to poultry production:

1. AS 304 Poultry and rabbit production:

- Taught to BSc Animal Science students
- Covers aspects of local chicken production
- Classification of poultry species
- Systems of poultry management
- Feeding
- Housing and environmental requirements
- Poultry diseases

2. AS 316 Poultry management and nutrition

- Taught to BVM students
- Covers aspects of local chicken production
- Classification of poultry species
- Systems of poultry management
- Principles and practice of feed formulation
- Housing and environmental requirements
- Poultry diseases

3. AS 103 Introduction to animal health and production

- Taught to BSc Animal Science and BSc Agriculture students
- Covers aspects of local chicken production
- Factors limiting livestock production in the tropics
- Husbandry practices
- Poultry diseases

4. Masters in Veterinary Medicine – MVM

Subjects relating to chicken production:

VM 406 – 60 hours (lectures), 60 hours (practical)

VCL 504 – Clinicals

Open University of Tanzania

- A need-driven course in poultry is in the process of being prepared.
- Staff can also develop short courses and modules according to demand.
- Rural poultry programs—for those who cannot attend full-time university or institute, there are correspondence courses held in conjunction with regional centres for training and exams.
- OUT conducts certificate, diploma and postgraduate courses.

Livestock Training Institutes

Certificates: Animal Health and Production Certificate (AHPC) – half paper, theory 26 hours, practical 33 hours, total = 59 hours; last revised in 2000.

Diploma in Animal Production (DAP) – full paper, theory 42 hours, practical 48 hours, total = 90 hours; last revised in 2003.

Other courses available

- 4H is a program supported by a non-government organisation that promotes poultry projects for primary school children.

- The Vocational Education Training Authority promotes vocational courses in agriculture. It runs adult education courses that include material on poultry. The courses are implemented through the Ministry of Community Development and Gender, and its 'folk development centres'.

The impact of Newcastle disease control on smallholder poultry production in Mauritius

I.L. Prayag and R. Ramjee¹

Abstract

Consumption of poultry products is rising in Mauritius with the increasing affluence of the population. Newcastle disease was once the greatest constraint to production of chickens by commercial and village breeders. V4 vaccine is now produced locally and with 95% coverage of the chicken population, Newcastle disease is no longer a problem.

Introduction

The increase in the purchasing power of the Mauritian population during recent years has caused an increase in the demand for poultry meat and eggs. Local production of poultry meat has risen from about 21,000 tonnes in 1999 to 30,000 tonnes in 2003 (Table 1). The production of eggs in million units in 2004 was 227 compared with 191 in 1999. Table 2 gives egg production figures by weight.

Table 1. Production and domestic utilisation (tonnes) of poultry meat in Mauritius

Year	Production	Domestic utilisation
1999	20,900	20,476
2000	25,600	25,187
2001	27,200	26,857
2002	29,305	28,636
2003	30,000	29,388

These figures give a clear indication that poultry production is playing an important role in the livestock sector in Mauritius and is expanding rapidly to meet the increasing demand for meat and eggs.

¹ Division of Veterinary Services, Mauritius

Table 2. Hen-egg production and domestic utilisation (tonnes) in Mauritius

Year	Production	Domestic utilisation
1999	10,500	9,448
2000	12,000	10,867
2001	12,000	10,757
2002	12,500	11,241
2003	12,500	11,125

Past situation

In a report of the Food and Agricultural Research Council in 1987, mention was made of the following disease conditions affecting the poultry population:

- avian encephalomyelitis
- clostridial infections
- coccidiosis
- egg drop syndrome
- fowl cholera
- Gumboro disease
- infectious coryza
- lymphoid leucosis
- mange
- Marek's disease
- Newcastle disease
- pox disease

- pullorum disease
- salmonellosis
- worm infestations.

It was also stated that, in 1985, in an epidemic outbreak of Newcastle disease (ND), most of the backyard poultry of smallholders was destroyed.

Present situation

In order to avoid great losses from diseases, smallholders have been using improved stock purchased either from the Poultry Breeding Centre of the Ministry of Agriculture or from large commercial private farms.

Through existing free veterinary and extension services, risks from diseases have greatly diminished, and breeders receive support in the development of small-scale operations.

A source from the Agricultural Research and Extension Unit reported that, as at December 2004, there were 115 small breeders (60 for broilers and 55 for layers) spread across 66 localities of the country.

Poultry Breeding Centre, Ministry of Agriculture

The main objectives of the Poultry Breeding Centre (PBC) are the production and sale of good-quality day-old chicks (broilers and layers) to small and medium-size breeders.

For the period January–December 2004, the demand for chicks from smallholders was as shown in Table 3.

The monthly production of chicks at the PBC is detailed in Table 4.

Table 3. Demand for chickens in Mauritius in 2004

Type	Broiler	Layer	Broiler and layer	Total
No. of breeders	232	56	87	375
No. of chicks	31,825	8,712	11,255	52,792

Diagnostic section

Chicken disease cases at smallholder level are handled by the Animal Health Laboratory of the Division of Veterinary Services. Routine poultry disease diagnoses by the laboratory, based on post-mortem examinations, recorded the following pathological conditions over the January–December 2004 period:

- aspergillosis
- ascariidiosis
- ascites
- coccidiosis
- colibacillosis
- cannibalism
- enteritis
- infectious bursal disease
- infectious coryza
- omphalitis
- pneumonia
- worm infestations.

Table 4. Monthly production of different classes of chicks in Mauritius

Month	Pullets	Cockerels	Broilers	Total
January	6,300	6,478	32,625	45,403
February	5,667	5,645	31,801	43,113
March	5,792	5,849	39,643	51,284
April	2,813	2,763	31,199	36,775
May	699	788	25,400	26,887
June	9,455	9,438	41,512	60,405
July	13,068	13,383	34,956	61,407
August	17,519	17,439	56,031	90,989
September	11,779	11,933	39,790	63,502
October	10,124	10,129	33,222	53,475
November	14,934	14,726	35,766	65,426
December	11,410	11,486	22,895	45,791
Total	109,560	110,057	424,840	644,457

Source: Animal Health Laboratory

Virology section—Newcastle disease vaccine

Over the years, Mauritius has been importing animals and animal products from other countries. Despite this, the country has remained remarkably free from major infectious diseases, and only ND in poultry has been a major problem. Now, however, that disease, which can cause enormous economic losses, has been brought under manageable control through the use of vaccines prepared locally at the Animal Health Laboratory.

The production started in the early 1960s through propagation in embryonated eggs. The seed viruses derived from the Hitchner and La Sota strains were obtained initially from the Republic of Madagascar and later from the Central Veterinary Laboratory, Weybridge, United Kingdom. These were attenuated forms of the original viruses and were propagated in embryonated eggs to produce live, attenuated vaccines.

The vaccines provided a high degree of protection against the disease. However, the vaccines were not thermostable and had to be administered to all the birds in a flock to provide protection.

In 1987, a new development came in ND vaccine production with the introduction of the Australian V4 vaccine strain, obtained from Wisconsin, USA. After several laboratory and field trials spread over a period of 5 years, the vaccine, which is prepared in small lots to help smallholders, has been commercialised and is now being used by almost all small breeders. Medium- and large-scale breeders have also adopted the vaccine. The vaccine is being sold only in a freeze-dried state in 100 dose vials.

The V4 strain has made a major contribution to the control of ND and is the vaccine of choice at village level (Table 5).

Table 5. Sales of freeze-dried V4 Newcastle disease vaccine in Mauritius

Year	No. of doses
2002	1,937,700
2003	2,475,900
2004	2,505,400

Decentralising sale of vaccines

For many years, poultry vaccines were sold only at the headquarters of the veterinary services, and breeders had to travel long distances to purchase the vaccine. Part of the poultry population was consequently left unvaccinated and exposed to infection.

Decentralisation of the sale of vaccine to regional veterinary offices has now provided a proximate service to the breeding community, and the majority of breeders currently have access to the vaccine and are vaccinating their flocks.

Role of the Division of Veterinary Services and the Agricultural Research and Extension unit

Officers from the Division of Veterinary Services and the Agricultural Research and Extension Unit (formerly the Extension Services Division (ESD)) are constantly advising breeders on the use and importance of vaccine. Regular site visits are also made. In the mid 1970s, radio and television programs were organised jointly by the ESD and the Division of Veterinary Services to create awareness among breeders on of the benefits of adopting vaccine. Currently, more than 95% of the flocks are vaccinated against ND.

Conclusion

Newcastle disease, which was the most economically important disease in Mauritius causing annual losses more than 50 million rupees, has now become non-existent. The country has not witnessed outbreaks of the disease since 1993 and the use of the V4 strain has largely contributed to its eradication.

Comparative advantage of the use of a thermotolerant vaccine in the protection of rural chickens against Newcastle disease in Ghana

J.A. Awuni, T.K. Coleman and V.B. Sedor¹

Abstract

Rural poultry production systems in Ghana and in Africa as a whole face a number of health and husbandry problems that greatly limit their improvement. In a survey carried out to highlight these problems, Newcastle disease (ND) was acknowledged as the major constraint. Other constraints included diseases such as fowl pox and endo- and ectoparasites. Poor husbandry practices, such as lack of proper housing, resulting in high incidence of predation, and insufficient supplementary feeding, are other factors that have further limited the production potential of the rural chicken. The improvement of rural chicken production in Ghana therefore requires a holistic approach focusing on both health and husbandry practices.

This paper presents the results of a study comparing the effectiveness of a thermotolerant, live vaccine (ND I-2) and an oil-adjuvant inactivated vaccine (virus strain Brescia) in the protection of rural chickens against virulent ND. The I-2 ND vaccine, when administered twice (3 weeks apart) via eye-drop, was found to be as effective as the oil-adjuvant inactivated vaccine in the control of ND in rural chickens. Partial budget studies indicated that ND control interventions yielded a very high return.

The oil-adjuvant inactivated vaccine has been used for many years in the protection of rural chickens against ND. However, vaccination coverage has always been very low, resulting in insignificant protection of the rural chicken flocks with the consequent annual high mortalities of the birds due to ND.

Introduction

Poultry farming is one of the means used by African farmers to generate income and increase access to animal protein. It offers the best yield in converting vegetable calories into high-yield animal protein. Village poultry production is widely practised in Africa, especially among rural communities. The village poultry production systems of Africa are based mainly on the scavenging, indigenous chickens found in virtually all villages and households. These systems are characterised by low- or no-input supply in terms of feed and medication, and low productivity. Nevertheless, over 70% of the

poultry products and 20% of animal protein intake in most African countries come from village poultry. Therefore, increasing rural poultry production would benefit household food security both in increased dietary intake and income generation (Aichi 1998).

However, it is sad to note that rural poultry raising is not rated highly in national economies, because of the lack of measurable indicators. Production levels of rural poultry in many African countries fall far below desirable levels. Outputs in terms of weight gain, and the number of eggs per hen per year, are very low, and mortality rates are relatively high (Matthewman 1977; Awuni 2002), especially in young chicks. Several reasons have been suggested for this high mortality and low productivity, such as suboptimal management, malnutrition, predation,

¹ Accra Veterinary Laboratory, Accra, Ghana

disease, and poor quality of supplementary feeding if any such is provided (Minga et al. 1989; Aini 1990; Negesse 1991; Pandey 1992; Bagust 1994).

Among the diseases affecting rural poultry, Newcastle disease (ND) has been acknowledged as the major factor hindering the improvement of rural poultry production in Africa and is responsible for losses of over 80% of household poultry annually (Spradbrow 1988; Minga et al. 1989; Aini 1990; Bell 1992; Alexander 1997; VSD 1998). Other diseases such as fowlpox, colibacillosis, and endo- and ectoparasites also play a significant role. Apart from diseases, poor husbandry practices (lack of proper housing facilities, poor supplementary feed) characteristic of the rural poultry production systems in Africa further limit the production potential of the rural chicken.

In Ghana, the government is working hard to eradicate poverty by 2020. Rural chicken production, which is practised in almost all rural communities and peri-urban areas, is a sure way to ensure family food security and reduce poverty. A holistic approach to the improvement of rural chicken production, focusing on the improvement of health and husbandry practices, is imperative.

Attempts to control ND in village chickens in Ghana have not been successful. The conventional vaccines available are heat labile and packaged in multi-dose vials, making them unsuitable for use under rural conditions. The introduction of the thermotolerant I-2 ND vaccine into the country was seen as a way to overcome these problems.

The aim of the study reported here was to compare the effectiveness of the thermotolerant I-2 ND vaccine with that of an oil-adjuvant vaccine in the protection of rural chickens against challenge with virulent ND virus strains. The I-2 ND vaccine is being produced locally.

Materials and methods

The materials used for the study were:

- thermotolerant I-2 ND vaccine produced locally from the master seed provided by the John Francis Virology Laboratory, University of Queensland, Australia
- oil-adjuvant inactivated ND vaccine for parental administration, virus strain Brescia 108ELD50, Institute Zooprofilattico, distributed by Chemni de la Milletire, BP 7562, 37073, Tours, Cedex 2, France, Batch No. 2518

- a velogenic field strain of the ND virus isolated at the Accra Veterinary Laboratory in 10-day-old chicken embryos, with an embryo mean death time (MDT) of 36 hours
- an eye-drop applicator for the administration of the thermotolerant I-2 ND vaccine, calibrated to deliver 10 μ L of vaccine dose per drop
- a chicken feather stripped to carry 10 μ L of vaccine for the 'feather-brushing of the eye' route of application of the I-2 vaccine.

The study was carried out in two ecological zones (coastal and forest). In each of these zones, four villages were selected for the study. In each ecological zone, rural chickens of four female farmers in one village were vaccinated twice against ND using thermotolerant I-2 ND vaccine via eye-drop at an interval of 3 weeks. In a second village, the vaccine was administered by brushing the eye with a calibrated feather tip twice at the same interval of 3 weeks. Chickens in a third village were vaccinated with the oil-adjuvant inactivated vaccine by subcutaneous injection once, as per normal practice. Chickens in the fourth village were not vaccinated and served as controls.

In each of the test (experimental) and control groups, 530 birds were wing-tagged. Equal numbers of birds (530 birds per experimental group) were bled from each group for serological monitoring of their immune response to vaccination. Blood was taken from all chickens before vaccination, before the second vaccination with I-2 ND vaccine and 3 weeks after vaccination. The birds vaccinated once with the oil-adjuvant inactivated vaccine and the controls were bled at the same time intervals.

Monitoring of the immune response following vaccination was by serology (haemagglutination inhibition (HI), as described by Allan and Gough (1974)), and by field observation of the birds, especially during the peak periods of outbreaks of ND in the area. Interviews with farmers were used to evaluate the effect of ND outbreaks in their communities after the intervention.

Fifteen birds from the control group and each of the three experimental groups were purchased for laboratory challenge with a velogenic field isolate of the ND virus. The MDT of the challenge strain in 10-day-old chicken embryos was 36 hours, indicating that it was a velogenic strain of ND virus. The vaccinated birds (I-2 and inactivated ND vaccine groups) as well as the controls were challenged intranasally with a drop of the virus

suspension containing 10^6 EID₅₀. The birds were observed for any signs of ND (swollen head, dullness, droopy wings, greenish diarrhoea) for 2 weeks after being challenged with field virus and dead birds examined at necropsy for lesions characteristic of ND (haemorrhages in the proventriculus, necrosis of the Peyer's patches and caecal tonsils, haemorrhagic tracheitis, muscular haemorrhages). The virus was isolated from tissues (lungs, trachea, brain and spleen) and identified with ND-specific hyperimmune serum in a virus neutralisation test in 10-day-old chicken embryos.

A cost-benefit analysis was performed using the partial budget method to evaluate the effectiveness of each type of vaccine used.

Results

Serological results

The results from the HI test showed that the birds vaccinated with the inactivated vaccine and the ND I-2 vaccine via eye-drop were protected even after the first vaccination (Table 1).

Field monitoring of vaccinated birds

In the villages where the chickens were vaccinated with I-2 ND vaccine via eye-drop twice and the inactivated vaccine once, farmers were very happy with the results. There were no cases of ND reported and they did not lose any birds during the

field trial. In the third village where the chickens were vaccinated with the ND I-2 by feather brushing of the eye, farmers said there were cases of ND but the situation was not as devastating as in the previous year. There was no difference in the ND situation (mortality rate of 80%) after the exercise as compared to the previous year in the control villages. Farmers even attributed the deaths of their flocks to our sampling and it took the provision of veterinary drugs to convince them to accept the team back into the village.

Laboratory challenge

The results of the laboratory challenge trial were collected after the last bird died and no other bird showed any clinical sign of disease. The results are shown in the Table 2.

The results show that when the thermotolerant I-2 ND vaccine is administered via eye-drop twice, it is equally as effective as the inactivated vaccine in protecting rural chickens against virulent strains of the ND virus (Table 2).

Cost-benefit analysis

A cost-benefit analysis was made for the implementation of each intervention. The results showed that a return of 13.8 was obtained when the thermotolerant I-2 ND vaccine was used in the control of ND administered via eye-drop as compared to a return of 10.5 with the inactivated ND vaccine. With the

Table 1. Geometric mean haemagglutination inhibition (HI) titres for each experimental group determined at 0, 3 and 6 weeks after vaccination

Group	Vaccine used	No. of birds per group	Geometric mean HI titres (log base 2)		
			0	3 weeks	6 weeks
1	I-2 eye drop	530	1.8	3.2	3.8
2	I-2 feather brushing	530	1.5	2.5	2.8
3	Inactivated	530	1.9	3.8	4.5
4	Control	530	1.8	1.9	1.8

Table 2. Results of challenge with velogenic field Newcastle disease virus

Group	Vaccine used	No. of birds challenged	No. dead	No. survived	Protected (%)
1	ND I-2 eye drop	15	0	15	100
2	ND I-2 feather	15	3	12	80
3	Inactivated	15	0	15	100
4	Control	15	15	0	0

thermotolerant I-2 vaccine administered by feather brushing of the eye, the returns were just 10.1. The results are even better (a return of 154.9) when farmers themselves administer the ND I-2 vaccine. Tables 3–6 clearly demonstrate these returns.

Discussion

The thermotolerant live I-2 ND vaccine, when administered twice, via eye-drop, is just as effective as the oil-adjuvant inactivated vaccine in the control of ND in rural chickens.

Furthermore, it has the following added advantages over the inactivated vaccine:

- It is cheap and therefore affordable to all farmers.
- It does not require strict cold-chain facilities for transportation and hence is the vaccine of choice for rural communities.
- It is being produced locally and is thus readily available to farmers.
- Its application does not require specialised skills, and farmers can administer the vaccine on their own.

Table 3. Costs and returns of vaccination with I-2 Newcastle disease (ND) vaccine administered via eye-drop

Factor	Value	Costs	Value
1. No. of birds vaccinated with I-2 ND vaccine via eye-drop	530	1. Cost of I-2 vaccine for 530 birds @ €20 per dose: $530 \times €20$	€10,600.00
2. Survival (100%) due to vaccination—from challenge results	530	2. Allowances for veterinary personnel for field trips	€200,000.00
3. Survival (20%) in previous year after ND outbreak (from epidata)	106	3. Transportation	€200,000.00
4. Differential survival as a result of I-2 vaccination via eye-drop: $530 - 106$	424	4. Stationery	€20,000.00
5. Income from I-2 vaccination via eye-drop administration, considering average price of a village chicken to be €15,000 (Ghanaian cedis) per chicken: $424 \times €15,000$	€6,360,000.00	5. Total cost	€430,600.00
		6. Profit = income – costs	€5,929,400.00
		7. Return = profit ÷ costs	13.8

Table 4. Costs and returns of vaccination with the oil-adjuvant, inactivated Newcastle disease (ND) vaccine

Factor	Value	Costs	Value
1. No. of birds vaccinated with the oil-adjuvant inactivated vaccine	530	1. Cost of inactivated vaccine for 530 birds @ €250 per dose: $530 \times €250$	€132,500.00
2. Survival (100%) due to vaccination—from challenge results	530	2. Allowances for veterinary personnel for field trips	€200,000.00
3. Survival rate (20%) in previous year after ND outbreak (from epidata)	106	3. Transportation	€200,000.00
4. Differential survival as a result of vaccination with inactivated vaccine: $530 - 106$	424	4. Stationery	€20,000.00
5. Income from vaccination with the inactivated vaccine, considering average price of a village chicken to be €15,000 (Ghanaian cedis) per chicken: $424 \times €15,000$	€6,360,000.00	5. Total cost	€552,500.00
		6. Profit = income – costs	€5,807,500.00
		7. Return = profit ÷ costs	10.5

- The return from the usage of thermotolerant I-2 ND vaccine when farmers administer it by themselves is very high.

All these advantages will encourage adoption of the I-2 ND vaccine and lead to much wider vaccination coverage. The thermotolerant live I-2 ND vaccine can therefore replace the inactivated vaccine for the protection of rural chickens against ND. The partial budget data have shown that vaccination interventions give a high return.

Study results indicated that ND can be controlled in rural chickens effectively with the use of I-2 ND vaccine administered via eye-drop. Since new chicks hatch almost every 2–3 months, revaccination of chickens at 3-monthly intervals will ensure that these newly hatched chicks are protected against sporadic outbreaks of ND throughout the year. With effective control of ND in place, the second most important disease is fowl pox, especially among chicks. There are very potent

Table 5. Vaccination with I-2 Newcastle disease vaccine by feather brushing of the eye

Factor	Value	Cost	Value
1. No. of birds vaccinated with I-2 ND vaccine administered via feather brushing of the eye	530	1. Cost of vaccine for 530 birds @ ₵20 per dose: $530 \times \text{₵}20$	₵10,600.00
2. Survival (80%) due to vaccination— from challenge results	424	2. Allowances for veterinary personnel for field trips	₵200,000.00
3. Survival (20%) last year after ND outbreak (from epidata)	106	3. Transportation	₵200,000.00
4. Differential survival as a result of vaccination with inactivated vaccine: $424 - 106$	318	4. Stationery	₵20,000.00
5. Income from vaccination with the inactivated vaccine, considering average price of a village chicken to be ₵15,000 (Ghanaian cedis) per chicken: $318 \times \text{₵}15,000$	₵4,770,000.00	5. Total cost 6. Profit = income – costs	₵430,600.00 ₵4,339,400.00
		7. Return = profit ÷ costs	10.1

Table 6. Vaccination with I-2 Newcastle disease vaccine by feather brushing of the eye, performed by farmers themselves

Factor	Value	Cost	Value
1. No. of birds vaccinated with I-2 ND vaccine administered via feather brushing of the eye	530	1. Cost of vaccine for 530 birds @ ₵20 per dose: $530 \times \text{₵}20$	₵10,600.00
2. Survival (80%) due to vaccination from challenge result	424	2. Allowances for veterinary personnel for field trips	₵0.00
3. Survival (20%) last year after ND outbreak (from epidata)	106	3. Transportation	₵20,000.00
4. Differential survival as a result of vaccination with inactivated vaccine: $424 - 106$	318	4. Stationery	₵0.00
5. Income from vaccination with the inactivated vaccine, considering average price of a village chicken to be ₵15,000 (Ghanaian cedis) per chicken: $318 \times \text{₵}15,000$	₵4,770,000.00	5. Total cost 6. Profit = income – costs	₵30,600.00 ₵4,739,400.00
		7. Return = profit ÷ costs	154.9

vaccines available for the protection of commercial poultry against fowl pox. These could be easily used in the rural population. The soft tick, *Argas persicus*, and northern fowl mites, are a big threat to the survival of rural chickens, especially broody hens. Sulfur-based insecto-acaricides are effective in controlling them.

Conclusion

This study has clearly shown that rural poultry production can be improved when locally produced I-2 vaccine is used to control ND.

The results showed that a return of 13.8 was obtained when thermotolerant I-2 ND vaccine was administered via eye-drop as compared with a return of 10.5 with the injectable inactivated vaccine. With the thermotolerant, live vaccine administered by feather brushing of the eye, the returns were 10.1. The results are even better (a return of 154.9) when farmers themselves administer the ND I-2 vaccine.

Acknowledgments

The following people and organisations have contributed immensely in diverse ways to the successful completion of this work:

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Current situation with highly pathogenic avian influenza (HPAI) in Indonesia, with special emphasis on control at village level

Tri Satya Putri Naipospos¹

Abstract

Indonesia has both a modern, commercial poultry industry and very large numbers of village poultry. The first outbreak of highly pathogenic avian influenza (subtype H5NI) in 2003 was initially misdiagnosed as Newcastle disease. The disease spread widely, with the first human death being recognised in June 2005. Strategic control processes were introduced in January 2004. These included improved biosecurity, vaccination in infected and high-risk areas and selective culling. There is an emphasis on control at village level.

The poultry sector in Indonesia

The poultry industry in Indonesia consists of a large population of commercial chickens. The capacity of breeders is around 1.8–2 million day-old chicks per week for layers and 18–20 million per week for broilers. The layer population is 80–85 million, while broilers number 1.2 billion per annum. The population of backyard/village poultry is estimated to be 295 million local chickens and 45 million ducks, spread throughout Indonesia.

The main market for poultry is the rapidly urbanising population of Indonesia, mainly in Java, which is hence also a centre for production. Although Indonesia is not a poultry-exporting country, it has small and limited regional trade in day-old chicks and broilers with Singapore, Malaysia, Vietnam, Myanmar and Japan. This has been banned by importing countries following the emergence of highly pathogenic avian influenza (HPAI).

There are about 2,300 poultry companies across the country, and poultry workers number around 25,000. Figure 1 shows the structure of the poultry industry in Indonesia, where 58% of the poultry population is located in Java, 24% in Sumatra, mainly in North Sumatra and Lampung provinces, 6% in Kalimantan and 10% in South Sulawesi province. Only a very small percentage (2%) of the poultry population is in the eastern part of Indonesia.

The commercial integrators (sector 1) and other commercial farms (sectors 2 and 3) produce 80% of domestic poultry, whereas smallholders (sector 4) raise the remaining 20%, which is mainly indigenous poultry. The off-take from the considerable backyard/village poultry production system is not well documented but considered to be significant. Characteristics of each sector or poultry production system in Indonesia are described in Table 1. Around 30 million households raise local chickens and ducks. Newcastle disease is the main poultry disease prevalent in the country.

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The history of the current HPAI outbreak in Indonesia

High mortality of chickens in layer farms was reported for the first time in Legok subdistrict, Tangerang district, Banten province, in August 2003. The cause of the outbreak was initially diagnosed as very virulent Newcastle disease, until it was confirmed to be caused by the HPAI virus. The outbreak then spread very rapidly to 11 provinces in Indonesia between August 2003 and January 2004: six in Java, one in Sumatra, three in Kalimantan and one in the province of Bali.

The Director General of Livestock Services of the Government of Indonesia announced officially on 25 January 2004 that an HPAI outbreak existed in Indonesia, with nearly 20 million chicken deaths. The occurrence of the HPAI outbreak was also reported to the World Organisation for Animal Health.

The Director of Animal Health then announced on 3 February 2004 that the subtype of HPAI virus was H5N1. The disease continued to spread within the poultry population within many provinces, districts and subdistricts, but until 2004 did not infect humans. Figure 2 plots the number of poultry deaths due to HPAI between August 2003 and September 2005.

On 19 May 2005, the Minister of Agriculture informed that the H5N1 virus had been found in pigs in Tangerang district, but with no evident symptoms. On 28 June 2005, the Minister of Health announced that the first case of 'bird flu' in a human had occurred in Indonesia. Up to July 2006, HPAI resulted in 42 human deaths from 54 confirmed cases.

Current short-term strategies for controlling HPAI

Considering the wide distribution of the disease, the high number of cases and complexity of the disease's ecology, it was deemed economically too expensive and socially unwise to cull all the birds in the infected areas. Based on these considerations, the Indonesian Government adopted a series of measures known as the nine strategies:

1. improvement of biosecurity
2. vaccination in infected and high-risk areas
3. depopulation (selective culling)
4. compensation
5. control of movement of live poultry, poultry products and farm waste
6. surveillance and tracing back
7. restocking, stamping out in newly infected areas
8. public awareness
9. monitoring and evaluation.

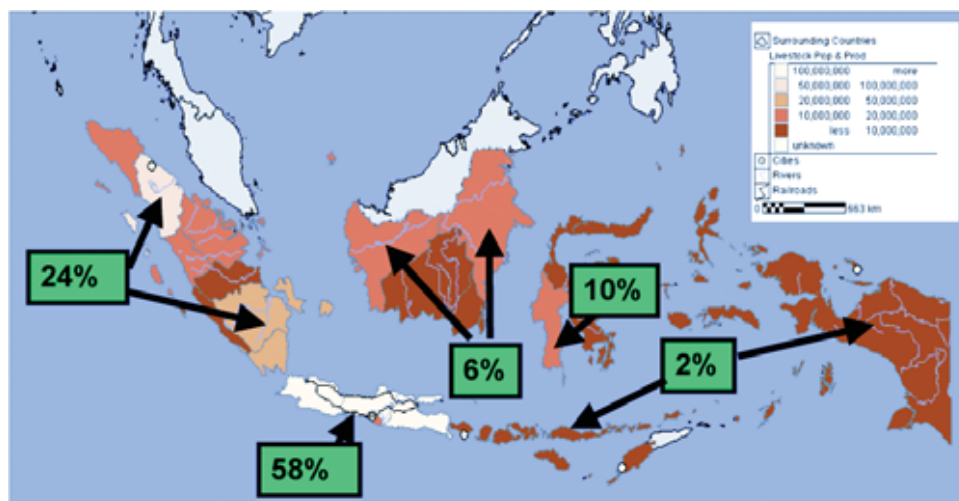


Figure 1. Distribution of commercial poultry numbers across Indonesia. Source: Information derived from Food and Agriculture Organization of the United Nations and Directorate General of Livestock Services (Indonesia) statistics.

These were introduced in January 2004. Mass vaccination linked to post-vaccination monitoring is the core national control strategy, but is only one tool that has to be carried out in conjunction with the other strategies. All breeder and layer farms (sectors 1 and 2; see Table 1) in the infected and high-risk areas are adopting vaccination routinely, using their own technical and financial capacity. Only 30% of broiler farms are adopting vaccination. Some breeders are adopting a ‘differentiating infected and vaccinated animals’ strategy and a few others are using a sentinel system.

The mass-vaccination campaign was launched by the government in July 2004, targeting poultry sectors 3 and 4. Vaccine is given free of charge. The government has provided nearly 300 million doses of vaccines, which are locally produced. The mass-vaccination program is supported by post-vaccination monitoring. The vaccinations have met with variable success, but with good success in especially the commercial sector. Seven regional disease-investigation centres and some provincial laborato-

ries have to handle large-scale diagnostic loads with post-vaccination monitoring. Tables 2 and 3 give the results of post-vaccination monitoring in different species of poultry.

The supporting equipment for the mass-vaccination campaign and surveillance—such as refrigerators, ice boxes, automatic and disposable syringes and cellmatics—is distributed to every infected province/district/municipality, the numbers of items provided being based on the poultry population in the area. In addition, personal protective equipment is distributed to infected provinces/districts/municipalities and regional laboratories.

Public awareness is a critical component of the HPAI disease-control program. The government has provided different types of public awareness materials on HPAI, such as roll-up banners, posters, flyers, booklets and video presentations. In order to support the mass-vaccination campaign, a radio-commercial program has been developed and broadcast for a certain period over several local radio stations throughout the infected areas.

Table 1. Characteristics of each category of Indonesian poultry production system

Characteristics	System			
	Industrial integrated	Commercial production		Backyard farming
		Biosecurity		
		High	Low	
	Sector 1	Sector 2	Sector 3	Sector 4
Type of production	Integrated	Contract farmers	Independent	Backyard
Biosecurity	High	Moderate-high	Low	Low
Selling products	Export/urban	Urban/rural	Urban/rural	Rural/urban
Dependency on input market	High	High	High	Low
Dependency on road transport	High	High	High	Very low
Location	Close to big cities	Close to big cities	Small towns and rural	Rural
Housing system	Indoor	Indoor	Half open	Open
Type of shed	Closed	Closed/open	Closed/open	Open
Contact with other chickens	No	No	Yes	Yes
Contact with ducks	No	No	Yes	Yes
Contact with wild birds	No	No	Yes	Yes
Veterinary services	Independent	Fee for service	Fee for service/ government	Government
Source of drugs and vaccine	Market	Market/contract farmers	Market/government	Government
Source of technical information	Contract farmers	Input agent/shop	Input agent/shop	Government

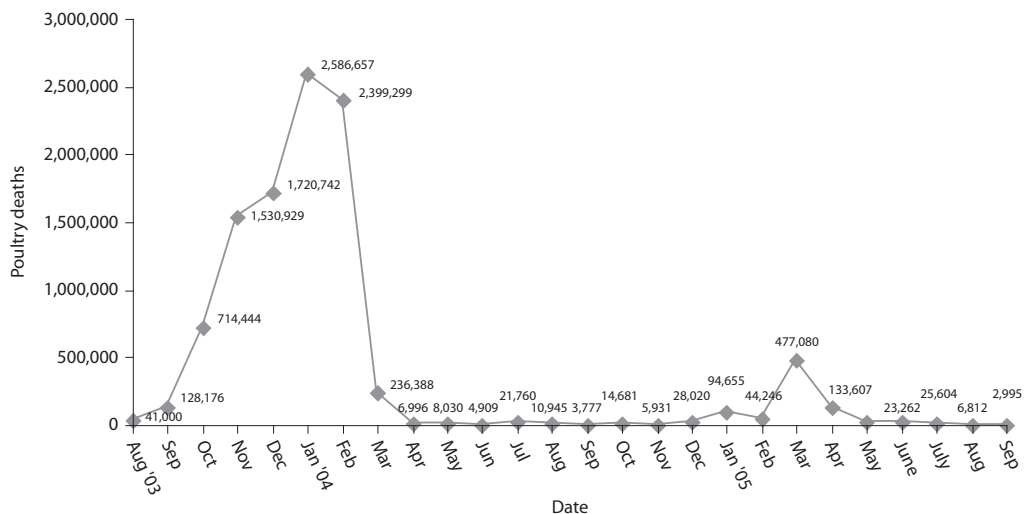


Figure 2. Numbers of poultry deaths due to highly pathogenic avian influenza in Indonesia between August 2003 and September 2005. Source: Information provided by Provincial Livestock Services, Indonesia.

Table 2. Results of highly pathogenic avian influenza post-vaccination monitoring in Indonesia, by poultry species and types

Type of poultry	No. of sera	No. of positives	Percentage of positives	Protective titre	Percentage of positives
Layer chickens					
Vaccination III	348	317	91.1	254	80.1
Vaccination II	638	542	85.0	414	76.4
Vaccination I	528	320	60.6	176	55.0
Total	1,514	1,179	77.9	844	Mean 71.6
Arabic chicken (an intensive breed)					
Vaccination III	150	144	96.0	134	93.1
Vaccination II	166	135	81.3	58	43.0
Vaccination I	136	78	57.4	17	21.8
Total	452	357	79.0	209	Mean 58.5
Ducks					
Vaccination II	204	112	54.9	73	65.2
Vaccination I	291	151	51.9	67	44.4
Total	495	263	53.1	140	Mean 53.2
Local chickens					
Vaccination I	410	81	19.8	46	56.8
Total	2,871	1,880	65.5	1,239	65.9

Source: Information provided by Disease Investigation Center, Region VI, Denpasar, in 2005

Medium- and long-term strategies for control, eradication and prevention, with an emphasis on control at the village level

Constraining factors in Indonesia had to be taken into account when considering control strategies in the medium and long term. These include the large and diverse poultry population, the large smallholder segment, weak veterinary infrastructure at the lower levels, and suboptimal awareness programs. On the other hand, that there were no human cases or fatalities at the beginning and during the 2004 epidemic masked the emergence of HPAI as a potentially serious disease. Recognition of the importance of HPAI increased due to the human deaths documented.

The weakness of the veterinary system has to be clearly recognised by the government. There is no strategic field surveillance and no improved epidemiological inputs that can assist the authorities to deal quickly with the disease and halt the spread of

HPAI across the country. The implementation of the strategic control plan is seriously hampered by the lack of clearly defined legal and regulatory frameworks under which disease control programs can be enforced in the field.

The impact of a government decentralisation system has had a significant influence on the government's ability to combat HPAI. This is evident from the difficulties in establishing the national policy base and managing the public sector budget being experienced at the district and subdistrict levels. Districts and subdistricts are independent from the central government and manage their own public funds, which has fragmented the flow of disease information and control programs from the national to the provincial level. This institutional constraint also hampers rapid and effective alert and response.

The implementation of medium- and long-term strategies (10–12 years) includes the following policy and legislation framework to support control of HPAI:

- veterinary capacity building

Table 3. Results of highly pathogenic avian influenza post-vaccination monitoring by type of vaccine used

Name of vaccine	No. of serum samples	No. of serological positives	Percentage serological positives	Protective antibody titre	Percentage of positives
H5N1 (Medivac)					
Vaccination III	473	434	91.8	390	89.9
Vaccination II	640	408	63.8	350	85.8
Vaccination I	711	245	34.5	147	60.0
Total	1,824	1,087	59.6	887	Mean 81.6
H5N1 (Vaksiflu)					
Vaccination III	225	190	84.4	113	59.5
Vaccination II	471	414	87.9	111	26.8
Vaccination I	229	76	33.2	22	28.9
Total	925	680	73.5	246	Mean 36.2
H5N1 (Afluvet)					
Vaccination III	40	22	55.0	17	77.3
Vaccination II	81	47	58.0	34	72.3
Vaccination I	152	26	17.1	4	15.4
Total	273	95	34.8	54	Mean 56.8
H5N2 (China)					
Vaccination III	20	19	95.0	18	94.7
Vaccination II	20	18	90.0	15	83.3
Vaccination I	15	14	93.3	6	42.9
Total	55	51	92.7	39	Mean 76.5
H5N2 (Biomune)					
Vaccination III	10	10	100.0	6	60.0

Source: Information provided by Disease Investigation Center, Region VI, Denpasar, in 2005

- program management training
- socioeconomic impact assessment
- risk-based surveillance programs
- eradication at source of infection
- epidemiology-driven disease-control activities
- policy/protocol/standard operating procedures when sero-positive results occur
- private sector involvement
- poultry sector restructuring.

The focus of the strategies, with special emphasis on control at village level from 2005 onwards, will be on pilot activities to support the current nine strategies as follows:

- enhancing farmer awareness
- implementing grassroots early warning
- establishing village-based field surveillance systems
- upgrading veterinary support
- establishing emergency preparedness.

The key factor in fostering farmer awareness is to empower the communities themselves. Therefore, the farmers' role in helping in control and prevention in their villages is of great importance in gaining grassroots cooperation.

Grassroots early warning and surveillance are two most important strategic components in early detection, early reporting and early response. The early warning and surveillance network will be formed around the members of village poultry farmers groups. These groups will form the village community's basic social core from which basic surveillance must originate. Village team leaders will be selected from leading village poultry farmers and trained to head up village surveillance teams. Farmers groups and animal health workers will be trained in simple disease recognition, sample collection and biosecurity.

Veterinary support at district level has to be given a high priority by the government at all levels. District veterinary laboratories will be upgraded with equipment, consumables and technician training, and dedicated to improved and increased HPAI diagnosis and serological survey. Emphasis will be placed on getting owners of sector 3 poultry farms to practise compulsory HPAI vaccination and undergo biosecurity training.

Emergency preparedness has to be ready at all times and fully adopted by field personnel and laboratory staff. Each district will be stocked with emergency gear and disinfectants to support stamping-out operations. Village groups and animal health workers will be trained in protocols for emergency stamping-out campaigns.

Conclusion and lessons learnt

Success in controlling HPAI in Indonesia needs a strong political commitment at the national and provincial levels to invest more resources in all aspects of disease control. Early diagnosis, reporting and rapid response have to exist at the grassroots level. District veterinary personnel have to understand the national policy and be adequately equipped to carry out comprehensive, active surveillance and mobilisation for vaccination programs. They must also be more effective and prompt in implementing biosecurity and other control measures. Eradication of the virus source from backyard poultry will be a difficult and long-term task. It is essential to explore disease-control options in carrier domestic ducks, including restructuring of domestic ducks and terrestrial poultry flocks, strategic culling of domestic ducks, and progressively enhancing flock immunity through vaccination, to reduce virus shedding.

Impact of avian influenza in the poultry sectors of five South-East Asian countries

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Abstract

Highly pathogenic avian influenza (HPAI), in most cases the strain H5N1, was officially reported in 10 east and South-East Asian countries in January 2004. More recent outbreaks of HPAI in July 2005 in poultry and wild birds in Russia, Kazakhstan, Western China and Mongolia have indicated that migratory birds probably act as carriers for HPAI over long distances. The countries most affected have been Vietnam, Cambodia, Laos, Thailand and Indonesia. As part of its response to the crisis, the Animal Production and Health Division of the Food and Agriculture Organization of the United Nations (FAO) implemented a regional project to assist with the post-HPAI rehabilitation. Socioeconomic impact studies were undertaken in each country to identify the effect on poultry producers, especially those most affected, to describe the major poultry production systems affected, and to formulate recommendations for both the short-term recovery and longer-term rehabilitation. FAO and the World Organisation for Animal Health (OIE) have made recommendations for the use of OIE-approved HPAI vaccines that can provide excellent protection and will reduce production losses and mortality. Where vaccination is a national option to protect small-scale poultry farming systems, a community-based approach is useful. This paper presents an across-country synthesis of the data and information generated by the project and the FAO activities.

Introduction

Highly pathogenic avian influenza (HPAI), previously known as fowl plague, is a highly contagious viral disease of domestic fowl and has been recognised since 1878. The virus is closely associated with water fowl, which are not usually affected by the disease and serve as the entry point of infection for domestic poultry. Many of the strains that circulate in wild birds are either non-pathogenic or of low pathogenicity to poultry. Virulent strains may, however, emerge, either by genetic mutation or by reassortment of less-virulent strains (Martin et al. 2006). The

number of recorded outbreaks of HPAI worldwide has increased over the past 10 years, culminating in early 2004 with unprecedented and almost simultaneous outbreaks of the virulent H5N1 strain of HPAI involving at least 10 countries in east and South-East Asia. The most affected countries were Vietnam, Cambodia, Lao People's Democratic Republic (Lao PDR), Thailand and Indonesia. By 2005, outbreaks of HPAI in poultry and wild birds had been reported in Russia, Kazakhstan, western China and Mongolia (FAO 2005).

It has long been known that wild birds represent a reservoir for avian influenza (AI) viruses worldwide. This is a concern because many of these birds are migratory and travel over long distances across international borders. Wild birds have also been shown to introduce novel influenza gene segments into a population that, when reassorted with existing viruses, can generate a new virus with different

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antigenic and biological characteristics. Influenza viruses are easily spread by fomites and survive and spread well in water. Furthermore, certain species of ducks are able to carry influenza viruses without exhibiting any clinical signs of disease (Martin et al. 2006). The epidemiological analysis of the disease identified strong association between free-grazing ducks in wetland rice production areas and avian influenza outbreaks in nearby domestic poultry (Gilbert and Slingenbergh 2004).

As part of the response of the Food and Agriculture Organization of the United Nations (FAO) to the HPAI crisis, in 2004, under its Technical Cooperation Programme (TCP), it commissioned a study to assess the impact of the outbreak, with the aim of designing post-AI rehabilitation programs in five countries: Cambodia, Indonesia, Lao PDR, Thailand and Vietnam.

The avian influenza impact studies

While the countries selected for the study are located in the same region they differ in several aspects. Cambodia and Lao PDR have the smallest human populations and the lowest population densities and per-capita incomes in the region. In these countries, around 80% of the human population live in rural areas. Table 1 summarises some key demographic indicators of the selected countries.

Per-capita income and population size and density are important determinants for the development of a modern commercial poultry sector. Thailand has a high per-capita income, a high population density and the highest level of urbanisation—Bangkok is projected to become one of the world’s biggest metropolises. A combination of these factors, along with a strong domestic economy and export-led growth, created the conditions for a strong commer-

cial poultry sector, which was (until the avian influenza crisis) the world’s fourth-largest exporter of poultry meat. The Indonesian population density is similar to Thailand’s, but its per-capita income is less than half, although still much higher than that of Lao PDR, Cambodia and Vietnam. Again, the combination of per-capita income and urbanisation created conditions favourable for a large-scale commercial poultry sector. Likewise, Vietnam, which has the highest human population density, a higher per-capita income than either Cambodia or Lao PDR and 25% urbanisation, also provides the growing conditions for a commercial poultry sector.

Methodology and implementation arrangements

As described by Dolberg et al. (2005), the impact studies have been completed for Cambodia, Indonesia, Lao PDR and Vietnam. In each country, a local institution was contracted to undertake the survey, which included information on the local poultry production systems; current estimates of poultry numbers; estimates of income from the sale of birds and eggs; mortality (by species and age); major constraints faced by producers; details of any animal health care and vaccination and an estimate of related expenses over the period of AI outbreaks. Standard questionnaires have been used.

In Cambodia, the study was undertaken by the NGO Vétérinaires Sans Frontières, France (VSF-F) and covered five provinces. In Indonesia, the Indonesian Centre for Agricultural Socio-economic Research and the Agency for Agricultural Research and Development carried out the study, which covered five provinces on Java: Banten, West Java, Central Java, Yogyakarta and East Java. The study in Lao PDR was conducted by the Department of

Table 1. Demographic indicators for the five countries involved in the project

Countries	Human population			
	Population (million)	People/km ²	Per-capita income (US\$)	Percentage of population in urban areas
Lao PDR	6	24	310	20
Cambodia	12	71	280	20
Indonesia	212	117	710	30
Vietnam	81	247	430	25
Thailand	62	121	1,980	40

Source: World Bank (2004)

Planning in the Ministry of Agriculture and Forestry and included three provinces that had experienced outbreaks of H5N1. In Vietnam, the General Statistics Office of the Ministry of Agriculture, Forestry and Fisheries conducted the study, which covered three of the worst-affected provinces: Ha Tay in the north, Thua Thien Hue in central Vietnam and Tien Giang in the south.

Description of the poultry sectors

Several distinct production systems exist in the five countries, but two broad distinctions can be made—the traditional village and backyard system, and the modern commercial system. The study used a classification system developed by FAO (2004) to describe the poultry sectors in each country. Table 2 identifies the different aspects of biosecurity and marketing arrangements that are associated with the four categories of farm.

Sector 1. Industrial integrated production.

Systems in this sector are typically located close to good infrastructure, utilities, communications and market outlets such as large cities, harbours or airports, which facilitate the import of breeding stock and feed, and the export of poultry products. Production includes broilers, layers or breeding enterprises. Companies involved have a high level of vertical integration (breeding, feeds, processing and marketing) and maintain high standards and levels of biosecurity.

Sector 2. Commercial production. Systems in this sector are typically medium-size commercial poultry production enterprises that may produce either boilers or layers that are sold in the domestic (urban and rural) market. These farms maintain a moderate to high level of biosecurity, with their birds kept indoors, so preventing contact with other poultry or wildlife. In Vietnam, the farms included in this category had 150–2,000 birds, while in Indonesia the range was 5,000–10,000.

Sector 3. Small-scale commercial production.

Systems in this sector have many similarities to sector 2 but the units are smaller and the level of biosecurity is much lower. Birds may be caged in open sheds or they may spend time outside the shed and mix with other species. The products are sold in live markets in urban and rural areas. In Vietnam, the size of such farms included in the study ranged from 50 to 150 birds, while in Indonesia the range was 500–10,000. Most of the commercial farms in Lao PDR and Cambodia tend to fall in this category.

Sector 4. The village or backyard system.

Systems in this sector are the most widespread and are practised by millions of households in all five countries. Many of these households are amongst the poorest and most vulnerable. Women are predominantly responsible for the daily management of poultry and they are also frequently the bird owners and decision-makers. Biosecurity is usually nonexistent.

It is believed that infection is more likely found in sectors 3 and 4, and these sectors (in particular, sector 4) are very difficult to protect and continue to be neglected. Smallholders are the most vulnerable group and they are slow to recover from disease outbreaks (Dolberg et al. 2004).

Distribution pattern of the outbreaks

The most detailed analysis of the distribution pattern of the HPAI outbreaks is based on the second wave of outbreaks in Thailand (Gilbert and Slingenbergh 2004). This analysis found that it is difficult to show a pattern of occurrence as far as the individual farms are concerned, but there was a strong association between free-grazing ducks in wetland rice production areas and AI outbreaks. Suphanburi province, north of Bangkok, with 43% of the AI outbreaks in ducks, was identified as the epicentre for ducks, while the infection distribution for chickens was

Table 2. Classification system for poultry production systems (FAO 2004)

	Sector 1	Sector 2	Sector 3	Sector 4
System	Industrial integrated	Commercial	Commercial (small scale)	Village/backyard
Biosecurity	High	Moderate to high	Low to minimal	Minimal
Marketing	Commercial	Usually commercial	Birds usually sold in live bird markets	Birds and products consumed locally

more uniform over the country. One implication noted by that study was that ducks may play a role in generating outbreaks in chickens, but that the reverse transmission does not occur.

In all the countries, the initial outbreaks have been linked with densely (human) populated areas such as the Mekong and Red River deltas in Vietnam and close to urban areas, i.e. in locations with a high demand for poultry meat, typified by tourist destinations such as Siem Riep in Cambodia. In Indonesia, the initial outbreaks were on farms in Central Java, and the disease spread when the owners of sick birds sold them to the adjacent islands of Sumatra, Bali and Kalimantan. In Lao PDR, initial outbreaks were in and around the capital Vientiane. In Thailand, they were in Suphanburi province, a little more than 100 km north of Bangkok.

Socioeconomic impacts of the outbreaks

A distinction has to be made between direct and indirect socioeconomic impacts of the AI outbreaks.

Direct impact. The direct impact of an AI outbreak is that due to the death of sick birds, the sacrifice of infected or healthy birds, the cleaning of the farms and the associated costs and other implications for the farmers, their families and workers. In Vietnam, 58 of 64 provinces were affected and about 17% (44 million birds) of the total national poultry flock of more than 250 million birds was destroyed. Moreover, due to the crisis, the poultry sector has decreased substantially in size. The direct loss was estimated to be more than US\$200 million (General Statistics Office, Vietnam 2004). In the surveyed households, poultry production was the main economic activity for some 68% of male-headed poultry farms and 32% of female-headed poultry farms before the outbreak, while in July 2004 the survey found these rates had fallen to 30% and 12%, respectively. To compensate for the loss of income, many farms have switched to other activities—mainly pig production. Vétérinaires Sans Frontières in Vietnam, which conducted a case study (Delquigny et al. 2004) of a village in the highlands of north Vietnam, estimated that the smallholders lost between US\$69 and US\$108 when the loss of birds, income and consumption were all taken into account. Viewed from the perspective that, in Vietnam, 17% of the households earn less than US\$1 per capita per day and a further 64% live on less than US\$2 per capita

per day, then such losses have serious consequences for the households involved. In Indonesia, YUSDja and Basuno (2004) reported that there was infection in half of the 30 provinces and that 16.2 million birds either died from the infection or had been destroyed. The loss was estimated at US\$171 million, based on the typical value of US\$1–2 per bird, depending on whether it was a broiler or layer. Furthermore, the demand for day-old chicks in the infected areas fell by 58% for broilers and 40% for layers, while the demand for feed declined by an estimated 45%.

The number of birds killed is much lower in Lao PDR, where it is estimated that, in the three affected provinces, some 150,000 birds died or were culled, of which 120,000 were in the capital, Vientiane. In relative terms, this was not a large number and is estimated to be 1.1% of the total national flock or 14% of the commercial flock (Department of Planning, Laos, 2004). The figure was also low in Cambodia, where about 19,000 chicken, ducks and other species were destroyed, which is less than 1% of the national flock.

Indirect impact. The indirect impact includes all the effects associated with the AI outbreaks, such as meat price fluctuations for different livestock species, and increases in food prices and the cost of supplies and inputs.

In Indonesia, when the indirect losses are added to the direct costs to the broiler and egg producers, the total cost more than doubles from US\$171 million to US\$387 million. The indirect impact in Indonesia is also well illustrated by the data in Figure 1. For a live broiler, the price fell from around rupiah 8,000 per kg in January 2004 to as low as rupiah 4,000 in some locations by 26 February 2004 but recovered to pre-outbreak levels by the beginning of May 2004. The point is that this fall in price hit all producers, large and small, and irrespective of whether or not their birds were healthy or infected by AI. Also, such a drastic fall in demand and prices had consequences throughout the industry, especially for the producers of hatching eggs and day-old chicks. The demand for broiler hatching eggs fell from around 21 million per week in January–February 2004 to around 14 million per week by March 2004. The price of day-old chicks fell from rupiah 2200 to as low as rupiah 200 per chick over the period. In turn, this affected the producers of hatching eggs and parent stock

In all five countries studied, prices of substitute meats went up as the supply of poultry meat declined, and the prices of potential alternatives

such as pork and fish increased. As a result, households with few assets and no animals other than poultry experienced severe hardship from AI outbreaks. Another indirect impact is that small-scale producers have seen the number of birds in their flock decreasing. This is shown in the data of the impact study from Cambodia where, between July 2003 and July 2004, the mean number of birds fell by 44% from 43 to 24 and the number of households having between 0 and 10 birds was up from 5% to 25%. Similar data were obtained in Lao PDR and Vietnam (Dolberg et al. 2005).

Problems encountered in controlling the disease

The socioeconomic surveys document major gaps that were addressed with the participating countries during a final workshop of the FAO regional TCP project on post-AI rehabilitation held in Bangkok on 14–15 October 2004, namely:

- biosecurity is difficult to increase in sector 4 systems
- the capacity to deal with sector 4 is very limited but concerns millions of poor households
- there is low access to veterinary advice, production services, information
- limited surveillance and control of the disease
- difficulty in controlling the trade flow
- a tendency for compartmentalisation and vaccination.

Recommendations for control measures

Recommendations for control measures are presented in this section. They are based on the outcome of the final workshop of the FAO regional TCP project.

Biosecurity. The workshop recommendations stated the importance of increasing biosecurity at the poultry farm level and along the market chain. Biosecurity varies considerably between the different poultry sectors; sector 1 generally exhibits a high level of biosecurity, and poultry production will carry on through the compartmentalisation scheme that allows for export of poultry meat and eggs. Sectors 2 and 3 need to improve their biosecurity standards, otherwise the industry will not be able to meet the requirements of the marketplace and will fail. In sector 4, it is very difficult to effectively resolve biosecurity issues, due to the nature of operations with scavenging birds and mixed livestock species. Some policies are already in place in high-risk areas in Indonesia to force the farmers to keep birds fenced. It is anticipated that, in remote regions, the traditional farming systems will remain essentially unaltered. In other places, e.g. Thailand, some farming systems will be excluded, such as the free-range duck-farming system in the rice paddy fields, as it is seen as a likely source of AI outbreaks in chicken flocks.

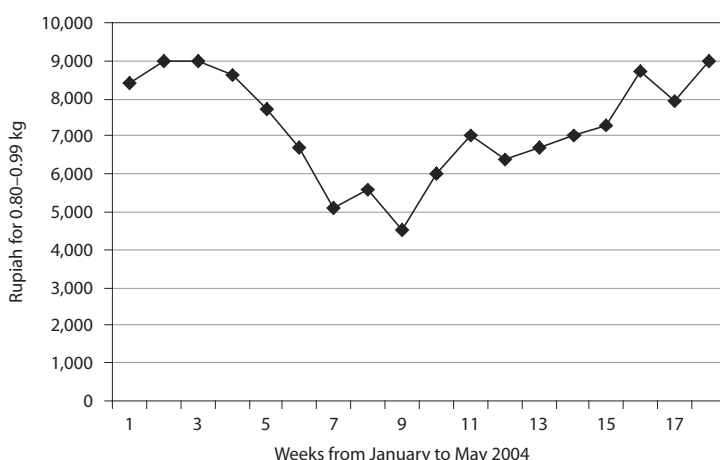


Figure 1. Broiler prices in and around Jakarta, Indonesia, January–May 2004. Source: Dr Hartono, Indonesian Poultry Information Centre.

Humans, fomites and animals should be considered major vehicles for the spread of AI and there is a need for a better understanding of biosecurity requirements by all stakeholders. It was recommended that the following principles be applied: biosecurity measures for the village and backyard system need to be developed with people's participation; the level of biosecurity should be applied according to the level of risk or threat; and the cost-effectiveness of biosecurity measures needs to be considered.

Vaccination. The workshop recommendations state that experiences in Asia and elsewhere show that vaccines can be successfully employed to assist in eliminating HPAI viruses, including H5N1 (in Hong Kong). Apart from Indonesia, only China and Vietnam in Asia are currently using vaccination to control H5N1 infection. Vaccination is still under consideration in other countries. FAO and OIE have made recommendations for the use of OIE-approved HPAI vaccines that can provide excellent protection and reduce production losses and mortality if they are used in an appropriate manner. Where vaccination is a national option to protect small-scale poultry farming systems, a community-based approach would be useful. Paravets (para-veterinary village workers) are commonly involved in vaccination programs in the villages in Vietnam and this is an efficient way to increase vaccination coverage.

Capacity building. There is a strong recognition of the importance of capacity building and public awareness to fill existing gaps in the control of AI. Capacity building should use all available resources, ranging from local to international organisations. Particular emphasis needs to be placed on the best husbandry practices at producer level, involving paravets and community leaders to build capacity in livestock production and animal disease prevention. The discussion of the workshop noted that smallholders were, in most cases, not aware of the reasons for the high mortality, and so did not respond in an appropriate manner. The role of paravets has been recognised as a very valuable tool to train farmers how to respond when an outbreak is suspected.

Public awareness. There is a strong and unfulfilled need for public awareness concerning the risks and impact of AI. While regulations, laws and standards have a role to play, they all suffer from either incomplete outreach or circumvention. Public awareness is an important tool to complement other initiatives, and a properly informed public will be able to make its own choices on actions to follow in

their own best interest. The need for awareness and information applies to all levels from decision-makers, administrators, veterinary officers, paravets and small- and large-scale poultry keepers. There is a need for the development of media plans that allow timely, concise and targeted information to be disseminated.

Special support to sector 4. It is estimated that this sector comprises between 136 and 209 million people in the five countries considered here, and it is the sector that includes the large proportion of the rural poor. The five country studies documented how this group continues to be neglected in terms of access to veterinary and other essential services. Smallholders have been the most vulnerable group during the HPAI outbreaks and they have been slow to recover. Additional support to this sector will help to secure their incomes and will encourage a commitment to ongoing surveillance and reporting systems.

Conclusions

It is important to recognise that the socioeconomic impact of AI is greatest on the poorest families, as a result of loss of birds and markets, low prices and lack of proper compensation for flock destruction (Dolberg et al. 2005). It is recognised that biosecurity, public awareness and capacity building and vaccination are the key elements to assist sector 4 poultry producers in fighting AI. Experience in the prevention and control of Newcastle disease has been developed over the past 15 years in Africa and in Asia. Lessons learnt from Newcastle disease control strategies could assist the formulation of appropriate strategies for combating AI.

Rural households with either little or no land frequently experience at least seasonal food shortages and they are therefore the target of any poverty alleviation or food security strategy. The FAO surveys document that the experience and institutional capacity to undertake participatory research and development with smallholder poultry farmers in the five respective countries is very limited. Efforts to increase productivity and good husbandry, and to fully implement a community-based approach to disease surveillance will not only increase household food security but also will be central to the future control AI in South-East Asia.

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Delivering systematic information on indigenous farm animal genetic resources of developing countries: inclusion of poultry in DAGRIS

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Abstract

This paper describes the objectives, historical development, structure, functionality, content, utility and future prospects of the Domestic Animal Genetic Resources Information System (DAGRIS) and the recent inclusion of poultry into the system, which aims at delivering systematic information on indigenous farm animal genetic resources of developing countries. DAGRIS is a public-domain electronic information resource designed to cater for the needs of researchers, policymakers, development practitioners, teachers, students and farmers in developing countries. It has been developed and managed by the International Livestock Research Institute (ILRI) to facilitate the compilation, organisation and dissemination of information on the origin, distribution, diversity, present use and status of indigenous farm animal genetic resources from past and present research results. So far, DAGRIS covers three ruminant livestock species (cattle, goats and sheep) and countries in Africa. Currently, the database is being expanded to cover more livestock species (poultry and pigs) and selected countries in Asia. The chicken component of DAGRIS now includes 127 breeds/ecotypes from African and Asian countries and some trait records for 50 of them. Because of a dearth of research information on the evolutionary history of chickens, their classification at subspecies level is slightly different from that of the three ruminant species, and lacks breed groups and subgroups. These groupings would have some leading information on the origin, distribution and development of the different breeds/strains/ecotypes in different regions and countries. Apart from chickens, DAGRIS thus far has the structure and functionality suitable to also capture breed-level information for geese, turkeys and ducks. ILRI, in collaboration with the range of national and international stakeholders, will continue to jointly develop comprehensive lists of breeds for these species. These will then be used to collate breed-specific research information from both published and grey literature. Currently, DAGRIS is available free of charge on the internet (<<http://DAGRIS.ILRI.CGIAR.ORG/>>) and as a CD-ROM. In the near future, DAGRIS will be developed to have a component for molecular genetic information and a module to allow all its users to upload uncovered breed-level research information into the database, to further expand the scope of information dissemination and distribution. This is part of a plan to assist selected national institutions administer their own versions of country-specific DAGRIS.

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Introduction

Poultry are an important source of food (both meat and eggs) and a means of investment that is important to the welfare of women and children in traditional and low-input systems in the tropics. However, an alarming 34, 37 and 45% of all avian breeds in Africa, the Asia–Pacific region and Latin America, respectively, are at risk of being lost (FAO 2000). There is an apparent lack of information about existing production problems, possible interventions and the performance of animals within the prevailing production systems to properly utilise the available genetic diversity to enhance production and design conservation strategies (Peters 1988; Tadelle 2003).

Workneh et al. (2003) argued that information on the extent of existing genetic diversity and the characteristics and use of indigenous farm animal genetic resources in developing countries is the basis for their present as well as future sustainable utilisation. Information has always been an important component of economic development, but it is becoming even more so as the world moves towards an information-based economy.

In recognition of this, the International Livestock Research Institute (ILRI) has been developing, since 1999, the Domestic Animal Genetic Resources Information System (DAGRIS), an electronic source of systematic information on indigenous farm animal genetic resources, focusing on cattle, sheep and goats of Africa. Currently, the database is being expanded to cover more livestock species (poultry and pigs) and selected countries in Asia. DAGRIS is a product of ILRI's research on livestock to develop international public goods in collaboration with its partners. It is part of ILRI's research agenda on the identification and conservation of indigenous livestock genetic resources of developing countries (Workneh et al. 2003).

This paper describes the objectives, historical development, structure, functionality, content, utility and future prospects of DAGRIS and the recent addition of poultry to its coverage.

Objectives of DAGRIS

DAGRIS has been designed and developed to facilitate the compilation, organisation and dissemination of information on the origin, distribution, diversity, characteristics, present uses and status of

indigenous farm animal genetic resources from past and present research results. It is meant to support research, training, public awareness, genetic improvement and conservation. The specific objectives of DAGRIS are to:

- compile and organise information on farm animal genetic resources from all available sources,
- maintain the integrity and validity of the information
- disseminate the information in a readily accessible way to all key stakeholders (researchers, trainers and their students, extension personnel, policymakers and farmers).

The contents of the database are backed by bibliographic sources. DAGRIS is also designed to help identify information gaps, provide easy access to information in the grey literature and highlight the risk status of breeds.

Historical development

The Animal Genetic Resources Group of ILRI in Addis Ababa, Ethiopia, has been developing the DAGRIS database. When the database was initiated in 1999, it was first mounted on a flat textual database on CDS/ISIS software developed by UNESCO. This system had more than 250 fields, all in one table, with extensive repetitions. It did not support graphics and was not user friendly. It also lacked standard data-exchange formats. Expansion of the database and its future plans to better deliver its contents over the internet have made it necessary to develop a new system using relational database management system (RDBMS) software, with appropriate database structure to efficiently and effectively document and disseminate animal genetic resources information. The new system was designed to have a simplified data-entry module, incorporating images and with improved sorting, saving and printing facilities. There was also a need to maintain high-level data integrity and verification techniques. Based on these needs, the new DAGRIS database has been developed since early 2000. Test release of the web-based version of the database was made at the beginning of 2002 at the internet address <<http://dagris.ilri.cgiar.org/>>. Broad-ranging comments and views were received from users, and some improvements have since been made to the structure, functionality and content of the database. These led to release of Version I of the database on the internet at the same address in April 2003. Data compilation and entry have continued, and

the contents of the database have now grown to more than double their size during the test-release. Subsequently, the whole content of the database has been reconfigured on CD-ROM for distribution to a broader range of stakeholders with poor or no access to the internet.

Inclusion of poultry in DAGRIS

Unlike other farm animals, the origin and distribution of chickens is not well established and documented, even though the chicken is believed to be one of the earliest domesticated animals in the agriculture history of humanity and has had various uses and benefits in different times. The first scheme of classification of world chicken stocks was outlined by FAO (1973) and later by Crawford (1990a,b). They have classified chicken stocks based on breeding systems and specific genetic attributes. This classification also reflects the type of ownership and utilisation of chickens. Accordingly, chicken stocks of the world are classified into four broad categories: industrial, middle-level, indigenous or native, and feral. These categories reflect ownership and utilisation, and imply certain breeding systems and genetic stocks peculiar to each. The scheme lacks consistency in structure and content. Furthermore, the categories do not relate to origin and distribution of the different chicken breeds.

A second classification scheme (Skinner 1974) is based on the evolutionary process of chicken domestication in certain geographical regions of the developed world. It places pure-bred chickens into classes, breeds, varieties and strains. This scheme pays little attention to the indigenous chicken breeds/ecotypes/strains of Africa, Asia and Latin America.

The Society for the Preservation of Poultry Antiquities (SPPA) developed yet another scheme of classification, based on the major purpose of keeping chickens. It divides chicken stocks of the world into seven categories: industrial, traditional agricultural, historical, games, ornamental, exhibition and experimental. Details are presented on the website of the SPPA at <http://www.feather-site.com/Poultry/SPPA/SPPA.html>. This classification has considerable overlaps between the categories, lacks clarity, focuses only on stocks in developed countries and does not consider the origin and distribution of the chicken.

Generally, none of the existing schemes provides a comprehensive system of systematically classifying the domestic chickens of developing countries with due regard to present-day uses, potential for the future, and origin and distribution within and across countries. Such a system will have to be developed to treat indigenous chicken genetic resources with the same level of detail as accorded indigenous cattle, sheep and goats in DAGRIS. Mainly because of the very limited published information on the diversity, origin, distribution of the indigenous chickens of Africa and Asia, the structure and content of chicken information in the database is slightly different from that for other livestock. For example, in chickens, the words 'breed', 'strain' and 'ecotype' are often used interchangeably. From published information to date, it is difficult to find any grouping of chicken breeds/strains or ecotypes into higher hierarchies such as breed group or subgroup as are employed in DAGRIS in covering cattle, goats and sheep in Africa.

These groupings would provide some pointers to the origin and development of the different chicken breeds/strains/ecotypes. Such information would also reveal evolutionary associations between chicken ecotypes across countries. The available information provides only lists of chicken ecotypes/strains/breeds in the different countries and breed-level information.

Data structure of DAGRIS

In designing the database using the RDBMS model, specific data elements were identified and grouped into entity types. The relationships between the entities were identified, and each of the attributes of the entities and their descriptions defined. The Microsoft SQL Server 2000 engine is used to implement and run the database. Fifteen major tables exist in the structure of database: species, breed group data, breed data (general), breed data (country specific), trait data, population data, environmental data, image data, web link, country, region, trait category, trait type, bibliography (source) and contact (source) tables. Figure 1 gives a schematic representation of the internal links between the tables. The web interface of DAGRIS is developed using the Active Server Pages (ASP) scripting environment and is served using Internet Information Services (IIS) for the Microsoft Windows 2000 Server.

The core sections of the database are those structures containing organised trait-level information by each breed. There are one-to-many relationships between most of the tables, with the common field called breed code (name) that is introduced in almost all tables serving as main key-field joining tables.

Functionality

DAGRIS has three modules: browse, search and reporting, and entry. The browse module allows a quick skim through the contents of the database, with options to delimit the browse by species, breed groups or breeds, and hence speed up the search. The output presents breed description highlights, with direct access to the trait menu for further information. The search and reporting module enables the user to query the database targeting specific breeds, with or without specifying the country and status of the breed. It is also possible to initiate a search of the database from known bibliographic records.

The data-entry module is accessible only to the database administrator and data-entry personnel. Hence, the integrity of the database is ensured; i.e. users cannot add, change or delete data. Users can, however, download their search output. Other important functions provided by DAGRIS include:

- sort functions on search results

- options to specify the number of results to view on screen
- access to preset summarised information
- print, save, export (to another application) or email search results
- hyperlinks to relevant websites for further information on the breed
- help facilities.

Software and hardware requirements

DAGRIS is not dependent on any particular operating system, and runs on all of the following platforms: Windows 9x/NT/2000/XP, Linux, UNIX and Macintosh. It also operates on any of the following internet browsers: Microsoft Internet Explorer (3.X, 4.X, 5.X, 6.X); Netscape Navigator (4.X, 6.X), Generic Crawler (3.X) and Lynx. The particular browser that users have may have minimum hardware requirements for normal functionality. For instance, the Internet Explorer 4.x and Netscape Communicator 4.x for Windows 95 have the following minimal requirements:

- CPU: 486 (66 MHz or higher)
- memory: 16 Mb of RAM or more
- available disk space: 20–70 Mb.

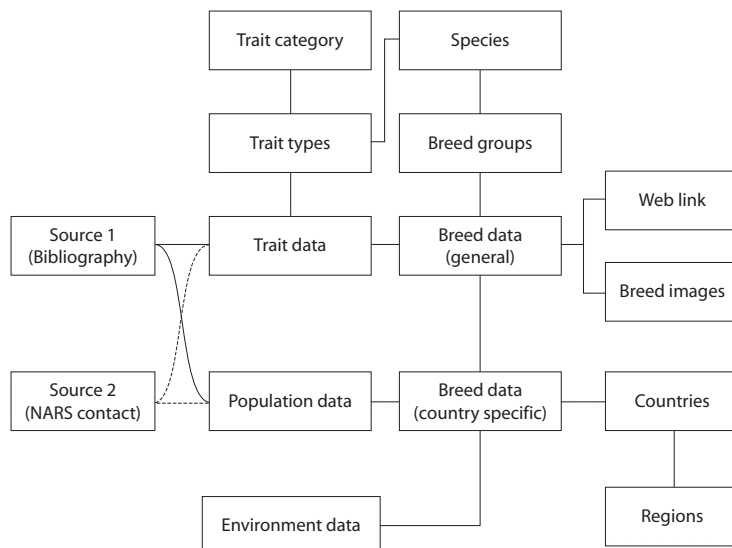


Figure 1. Structure and internal links of the Domestic Animal Genetic Resources Information System database

Netscape Navigator 3.x and Internet Explorer 3.x for Windows 3.x have lower minimal requirements:

- CPU: 386 or higher
- memory: 8 Mb of RAM or more
- available disk space: 7–12 Mb.

Content

The content and functionality of DAGRIS are designed to efficiently enlighten all stakeholders on the status and particularly useful attributes of recognised livestock breeds at the level of individual countries. The system initially covered cattle, sheep and goats of Africa, and has expanded recently to cover chicken breeds of Africa and, as its general scope expands to Asia, selected Asian countries. Currently, the database consists of 14,000 trait records on 152 cattle, 96 sheep and 62 goat breeds of Africa, and is expanding to cover more livestock species (poultry, pigs) from Africa and selected countries in Asia. The chicken component of DAGRIS now includes 127 breeds/ecotypes from African and Asian countries and some trait records for 50 of the breeds. Apart from chickens, DAGRIS thus far has the structure and functionality to also capture breed-level information on geese, turkeys and ducks. The publication date of bibliographic records in the database ranges from 1927 to 2004, indicating a broad reference base of the published and grey literature. All output pages have printable versions made available on the click of a button. When a breed search output is displayed, the name of the respective breed group is also displayed, with functional links to search for other breeds within the breed group. To ease the search process for specific traits, and hence improve system speed, a summary list of traits is presented as a lead-in to the actual trait records. This additional hierarchy shows a list of traits for which data are available and, on the click of another button, a list of traits for which no data are available. The latter is particularly important to alert users to missing trait information, which serves as a prompt to both users and the database administrators to search for missing information.

Future prospects of DAGRIS

In terms of geographical coverage, DAGRIS currently covers Africa, where about 72% of ILRI's present research activity is directed. Its scope is

expanding, particularly in Asia, which region, according to ILRI's global poverty map, is home to 57% of the world's poor dependent on or associated with livestock (Thornton et al. 2002).

Data entry and verification will continue under the DAGRIS team at least in the short term. The long-term management of the database is under discussion. Meanwhile, additional system structures will be introduced to:

- accelerate data collection at country-level
- extend the geographic and species coverage to selected developing countries in Asia
- develop a search module based on trait descriptors
- develop an open data capture system (within a Global Environment Facility–United Nations Environment Program (GEF-UNEP) Asia project)
- develop a model for national databases (within a GEF-UNEP Asia project)
- develop a module for extraction and customised analysis of phenotype and molecular genetic data within and between data sources
- geo-reference breed-level data (GIS-links)
- identify national focal institutions at country level (first in Africa) and test country modules of the database in relation to the main database.

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Effect of feeding regime during the starting phase on performance of growing village chickens

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Abstract

Village chickens contribute to basic socioeconomic welfare in rural families. Increased productivity of village chickens can break the vicious cycle of poverty and malnutrition in rural households. In addition to Newcastle disease, insufficient nutrition is also a factor affecting rural poultry production in Uganda. A study was designed to investigate the effect of nutrient density of chick diet on performance of village chickens. Two experiments were conducted. In experiment 1, chicks were subjected to one of three dietary treatments of crude protein (CP): 21%, 18.5% and 17%. The three diets were isocaloric (11.30 MJ/kg). In experiment 2, chicks were divided into two groups and offered either commercial chick mash (21% CP, 12.55 MJ/kg,) or commercial growers mash (16% CP, 11.30 MJ/kg). Experimental diets were offered to caged chicks for 6 weeks in experiment 1, before releasing the birds, and for 14 weeks in experiment 2. While on the range, all birds were supplemented with growers mash rationed to 60% of their daily requirement. The mortality rate in experiment 1 was high because chickens were released at a young age. There was no significant difference ($P > 0.05$) in growth performance of between groups of birds in experiment 1, while in experiment 2 the chicks fed on chick mash performed significantly better ($P < 0.05$) than those that fed on growers mash. This advantage was lost later on, when birds were on the range, but it was regained at sexual maturity. In both experiments, pullets that fed on high-density diets were bigger and attained sexual maturity much earlier than their counterparts. These findings suggest that good-quality starting diets are essential for better performance of village chickens.

Introduction

The population of poultry in Uganda is approximately 23 million (MAAIF 2004), with chickens constituting over 60% of that population. Eleven of the 14 million chickens (79%) are the free-range local village chickens. The village chickens are found in almost every rural household (UBS 2002) and contribute to basic socioeconomic welfare in rural families and to various cultural roles that vary from community to community. In some parts of

eastern and northern Uganda, birds are bartered in a livestock stocking process (MAAIF 1996). In spite of the introduction of exotic commercial birds in the 1960s, indigenous birds have maintained a lead role in rural areas. Village poultry have great potential and occupy a unique position in rural communities through their capacity to provide valuable protein to smallholder farmers. However, this is always constrained by low numbers kept, because of limited feed resources and poor health of birds. Increased productivity of village chickens can break the vicious cycle of poverty, malnutrition and disease in rural households. The chickens are a source of cheap, high-quality protein for resource-poor households, the sick and malnourished, especially those affected by HIV/AIDS, and young children.

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Newcastle disease remains the major hindrance to increased poultry productivity in rural areas. In addition, insufficient nutrition is seen as a major factor affecting rural poultry production. Intervention strategies in nutrition need to focus especially on young chicks since they are the most vulnerable group in scavenging systems. A study was therefore designed to investigate the effect of the nutrient density of chick diet on subsequent performance of vaccinated free-range village chickens.

Materials and methods

A flock of 25 breeding hens was selected and allowed to produce fertile eggs. One hundred and thirty-five eggs were collected and set, 15 each, under nine broody hens. Hatchability was 86% on average, and each hen was given 12 chicks to brood for 15 days. In the first experiment, the chicks were divided into three groups that were fed on three diets that differed in crude protein (CP) content—21% CP, 18.5% CP and 17% CP (diets 1, 2 and 3, respectively)—but were isocaloric (11.30 MJ/kg). Each treatment had three replicates. The replicates comprised 12 chicks that were kept in cages until they were 6 weeks old. In the second experiment, the chicks were divided into two groups, with one group feeding on commercial chick mash (21% CP, 12.55 MJ/kg) and the other on commercial growers mash (16% CP, 11.30 MJ/kg) for 8 weeks, after which both groups were all fed on the growers mash. In both experiments, feed and water troughs were put

in the cages. Water was provided ad libitum and soluble multivitamins were also given in the first week to prevent possible deficiencies. After release from the cages, the birds were offered supplementary feed at the rate of 60% of their daily requirement, given water and allowed to feed from the range with the adult stock. Chicks were wing-banded at 6 weeks of age. Cockerels were identified at the age of 4 weeks. There were few of them and they were therefore not considered in the study. Vaccination against Newcastle disease was done at 7 days, 30 days, 10 weeks and 14 weeks of age, using a live vaccine (La Sota strain $\geq 10^{6.5}$ EID₅₀, Laboratorios Hipra, S.A. Spain²).

The feed offered was recorded daily and the feed intake computed every 2 weeks. Daily feed intake was calculated according to the total feed consumption of the group in each pen. The birds were weighed every 2 weeks. Mortality was recorded as it occurred, but also by comparing the initial number of birds and the number remaining at the end of 2 weeks, to account for birds lost to predators. At sexual maturity, pullets that were laying eggs were identified using the wing band numbers.

Results

In the first experiment, the average body weight of day-old chicks was 34 g. For the first 6 weeks, chicks on the three diets grew at the same rate

² EID₅₀ = 50% embryo infectious dose.

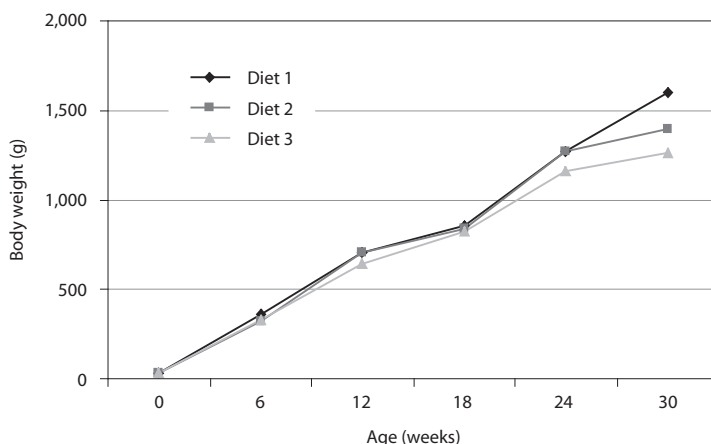


Figure 1. Growth performance of pullets in experiment 1

(Figure 1). However, while birds were on the range, those that had been fed on diet 1 (21% CP) appeared to grow faster than birds in the other two groups, although the difference was not statistically significant. The exception was in body weight of pullets at 7 months of age, when pullets that had fed on diet 1 became significantly bigger than those on other treatments and had attained sexual maturity at 6 months of age. Feed consumption during the starting period (0–6 weeks) was similar across diets. There was an outbreak of fowl typhoid when birds were 8 weeks of age and the mortality rate was higher for birds that had been fed on diets 2 and 3, implying that those that had fed on diet 1 were relatively more tolerant of the disease.

In the second experiment, the average body weight of day-old chicks was 33.5 g. The nutritional quality of the starting diet significantly affected growth performance of the birds. Birds that were fed chick mash were bigger than those on growers mash throughout the whole period (Figure 2). As reflected in the body weight at 16 weeks of age, growth rate of pullets was depressed when they were let out on the range. Although birds recovered from this shock, those that had been fed on growers mash did not show any compensatory growth. These birds consumed slightly less feed than those on chick mash. Mortalities during the first 14 weeks were only 3% for each dietary treatment. No mortalities were incurred when birds were let out on the range. Pullets that had fed on chick mash were bigger and attained sexual maturity a month earlier than their

counterparts. The relatively large body size was associated with bigger eggs at point of lay.

Discussion

Chickens in experiment 1 did not show a significant difference in growth performance, probably because the three experimental diets were isocaloric and not much different in protein content. The big difference in body weight at sexual maturity was attributed to the reproductive status of the pullets, suggesting that a high-protein starting diet has a positive effect on the reproductive performance of pullets. The growth rate of the chickens provided with high nutrient density starter diets in the second experiment was higher and there was therefore a higher requirement for feed to meet both growth and maintenance requirements of the birds (NRC 1994). Aini (1990) and Roberts (1992) reported a reduction in growth performance when birds were released to the range. Under scavenging conditions, the nutritional status of chickens is usually below the birds' requirements (Rashid 2003) and this usually retards their physical development. The improved performance resulting from high nutrient density starting diets shows the high potential of village scavenging chickens when chick diets are improved.

Conclusion and recommendations

Performance of scavenging village chickens could be improved by applying preferential feeding strat-

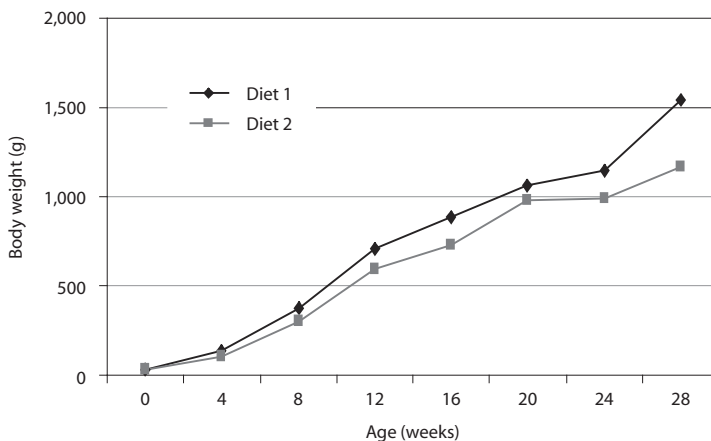


Figure 2. Growth performance of pullets in experiment 2

egies for young chicks. This would require cash inputs but, if farmers are to increase production, they must become market-oriented. Cheap, non-conventional feed resources such as worms and insects could be exploited to improve chick nutrition.

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Technical efficiency of family poultry production in the Niger Delta, Nigeria

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Abstract

This study assessed the technical efficiency of family poultry production in the Niger Delta, Nigeria. A multistage sampling technique was employed to generate information from 116 respondents through the administration of a questionnaire. The relevant information from 116 respondents was analysed using descriptive statistics, profitability ratio and a stochastic frontier production function (SFPF) model. The results of descriptive analysis showed that 53% of the respondents were involved in family poultry production for sale, while 39% were producing poultry for home consumption. Profitability analysis showed that backyard poultry production is profitable with average annual profit of Nigerian naira 38,834 (=US\$290) and a return on investment of 7.60. The SFPF analysis showed that feeding, capital and medication had significant and positive relationships with the output of the family poultry. The result of SFPF analysis further showed that the technical efficiency of family poultry increases with an increase in family size and innovation adoption, and that women were more technically efficient in family poultry production than men. The estimated technical efficiency of family poultry production ranged between 0.09 and 0.63, with mean of 0.22. This indicates that, on average, the respondents are 22% efficient in the use of the combination of their inputs. The elasticity estimate was 12.29, which indicates that family poultry production is taking place at stage 1 (inefficient stage) in the production curve. This study concludes that the output and technical efficiency of family poultry production can be increased by the use of more feed, capital and therapeutic agents, and the adoption of more innovations. The study recommends that extension agencies should be mandated to disseminate improved technology that will stimulate family poultry production in the study area. Capital can be channelled to family poultry production through the provision of micro-credit and the formation of cooperative societies. Medicine and vaccines should be provided for family poultry production at affordable prices through the assistance of poverty-alleviation schemes and oil companies in the study area.

Introduction

Poultry production has a high priority because poultry meat has better energy and protein conversion ratios than many other animal species and high

net return on investment (Alabi et al. 2000b). Poultry are the most prolific of all farm animals, being capable of producing up to 200 eggs or offspring per year (Akinwumi and Ikpi 1979). Furthermore, poultry products such as eggs and table birds (meat) are major sources of animal protein and contribute to the palatability of many dishes. Weight for weight, an egg contains about the same amount of animal protein as pork and poultry meat. It contains about three-quarters that of whole-milk cheese. Poultry have the greatest potential to contribute to an increase in livestock output in the

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short run. The high rate of return associated with the poultry industry, coupled with the simple management skills required, stimulated the increase in poultry production in the early 1980s in Nigeria. Short-term capital investment and the short gestation period of the birds are also contributing factors. Many of the commercial poultry farms have since collapsed because of multifarious problems facing them. Commercial poultry production in general is facing problems of poor nutrition, a low capital base, inefficient management, diseases and parasites, and housing and marketing problems (Alabi et al. 2000a).

For industrial poultry birds to express their full genetic potential, certain basic requirements must be provided. These include a benign environment, good management, balanced rations and adequate housing (Akinwumi and Ikpi 1979). These facilities can be provided through an adequate capital base, which is lacking in Nigeria. The high cost of feeds, the poor quality of day-old chicks, and inadequate extension and training facilities have been the bane of industrial poultry production in Nigeria. These problems associated with industrial poultry production make family poultry production popular in Nigeria.

Family poultry outnumber all other livestock in Nigeria. Commercial chicken holding accounts for only 10 million chickens or 11% of the total chicken population of 82.4 million (Sonaiya 2000). Families maintain the bulk of poultry in Nigeria under a low-input extensive system (Sonaiya 1995). Family poultry are important as providers of eggs and meat. The two production systems—free-range backyard and small-scale extensive—have flock sizes of 1–20 and 10–50, and productivities of 20–60 and 30–100 eggs per hen per year, respectively (Sonaiya 1996). Similarly, each hen can produce 13 kg of meat per year. Poultry are the most accessible livestock for the poor, and households with chickens survive and recover much quicker from drought, livestock diseases, war and famine. Small poultry holdings provide supplementary food, income and employment, and contribute to poverty alleviation (Sonaiya 2001).

It is generally assumed that family poultry production systems are economically efficient because, although the outputs from individual birds are low, the inputs are usually lower. This assump-

tion has not been properly investigated using an econometric model. The availability of econometric data will be important in transforming the family poultry production system. According to Kitalyi (1998), the transformation of family poultry into economically viable enterprises would require a better understanding of the socioeconomic aspects of the production system. This is consistent with the view of Sonaiya (2000) who opined that, as the socioeconomic importance of family poultry is being recognised, economic analysis is required to identify and evaluate problems, and plan appropriate intervention for development.

For family poultry production to grow in a sustainable manner, the present level of technical efficiency and productivity must be improved. However, little is known about the level of technical efficiency of the Nigerian poultry industry in general (Ajibefun and Daramola 1999). Indeed, so far been no study exists on the technical efficiency of family poultry in Nigeria.

Technical efficiency implies the ability to produce maximum output from a given set of inputs and given the available technology. Many past and present analyses of technical efficiency in the Nigerian agricultural sector involve the calculation of simple ratio measures, such as labour efficiency, capital efficiency or feed efficiency. These measures can be very informative but can be quite misleading, because each measure considers only a single input in isolation (Ajibefun and Daramola 1999). Increased production and productivity are direct consequences of efficiency of production resulting from the efficiency of the combination of inputs, given the available technology (Ajibefun and Abdulkadri 1999).

The study reported here aimed to determine the technical efficiency of family backyard poultry production in the Niger Delta. Specific objectives were:

- to assess the socioeconomic characteristics of the family poultry production in the study area
- to determine the cost and revenue structure of the family poultry production
- to estimate technical efficiency of each producer and to determine the technical efficiency of family poultry production.

Literature review and theoretical framework

Productive efficiency means the attainment of production goals without waste. Beginning with this basic idea of 'no waste', economists have built a variety of theories of efficiency. However, the fundamental idea underlying all efficiency measures is that of the quantity of goods and services per unit of inputs. Consequently, a farm is said to be technically inefficient if too little is being produced from a given bundle of inputs. Hence, enterprise inefficiency involves the disproportionate and excessive usage of all inputs. There are two basic approaches to measuring technical efficiency: classical and frontier.

The classical approach

This method, based on the ratio of output and a particular input, is termed a partial productivity measure in the sense that output is compared with only one input at a time. The most commonly used ratios are output per person-hour—i.e. labour productivity, output per unit of capital—i.e. capital productivity, and crop yield from a unit of farmland—i.e. land productivity. That it considers only one input at a time is the major weakness associated with this measure.

The frontier approach

Dissatisfaction with shortcomings of the classical approach led economists to develop advanced econometric, statistical and linear programming methods aimed at analysing technical efficiency related issues. Consequently, the frontier approach emerged and stimulated great interest among researchers and policymakers. All the abovementioned methods have in common the concept of frontier. The implication is that efficient farms are those operating on the production frontier, while inefficient farms are those operating below the production frontier. The amount by which a farm lies below its production frontier is regarded as the measure of inefficiency.

The stochastic frontier production function and technical efficiency

Farrell (1957) proposed a method of measuring relative efficiency that could account for all factors of production simultaneously. He proposed

measuring the technical efficiency of a firm in an industry by comparing its observed output to the output that could be produced by a fully efficient firm, given the same bundle of inputs. Many subsequent papers have applied and extended Farrell's ideas. This literature may be roughly divided into two groups, according to whichever of two methods—mathematical programming or econometric estimation—is chosen to estimate the production function of the fully efficient firm (which is now commonly referred to as the frontier production function).

The mathematical programming approach to frontier estimation has become known as 'data envelopment analysis' (DEA). Seiford and Thrall (1990) provide a thorough review of the DEA literature. The primary shortcomings of the DEA approach are that measurement errors can have a large influence upon the shape and position of the estimated frontier, and that it is not possible to use standard statistical theory to test hypotheses about the production parameters. Aigner et al. (1977) and Meeusen and Van den Broeck (1977) independently proposed a stochastic frontier production function to address these problems. Stochastic frontiers have two error terms, one to account for technical inefficiency, the other to account for factors such as measurement error in the output variable, luck or weather. Greene (1993) reviews the literature on the econometric estimations of stochastic frontiers.

A stochastic frontier production function may be expressed as:

$$Q_i = f(X_i\beta) \exp(V_i - U_i), i = 1, 2, \dots, N \quad (1)$$

where Q_i is the output of i th firm, X_i is a vector of inputs, β is a vector of parameters to be estimated, $f(\cdot)$ is a suitable functional form such as the Cobb-Douglas or translog, U_i is a symmetric random error that is assumed to account for technical inefficiency in production, and V_i accounts for other factors, such as luck or weather, that affect the output of the farmers but are beyond their control. The values of the unknown parameters of these models are usually estimated by maximum likelihood, after making assumptions about the distribution of U_i and V_i , which are often assumed to be normal and half-normal, respectively.

Several empirical frontier studies have not only predicted technical efficiencies of firms in an industry, but also have attempted to identify factors that contribute to one firm being more or less

efficient than another. One of the earliest stochastic frontier studies of this type was an empirical analysis by Pitt and Lee (1981) of the sources of technical inefficiency in the Indonesian weaving industry. In that study, a stochastic frontier production function was estimated by maximum likelihood, and predictions of technical efficiency obtained for each firm. These predicted technical efficiencies were then regressed upon variables reflecting the size, age and ownership structure of each firm, which were shown to have significant influence upon the degree of technical inefficiency of the firms.

Many subsequent studies have investigated the sources of technical inefficiency in a variety of industries, using similar two-stage methodologies. Papers by Kumbhakar et al. (1991), Huang and Lui (1994) and Battese and Coelli (1993) have questioned theoretical consistency of this two-stage approach and have proposed the use of stochastic frontier specifications that incorporate models for the technical inefficiency effects and simultaneously estimate all the parameters involved. All these papers enter the firm-specific factors into the technical inefficiency term of the stochastic frontier model specifications in quite similar ways. The Battese and Coelli (1993) specification, which is equivalent to the Kumbhakar et al. (1991) model, was used in this paper. The model specification is similar to equation (1), except that the U_i are assumed to be random variables that are independently distributed with truncation at zero of a normal distribution with mean m_i and variance δ^2 ,

$$U_i = g(Z_i, \delta^2) \quad (2)$$

where Z_i is a vector containing firm-specific factors and a constant; δ^2 is a vector of parameters to be estimated and $g(\cdot)$ is a linear functional form.

Application of the stochastic frontier production function model in Africa

Various studies have been carried out on technical efficiency analysis of farmers in African settings, including those of Adesina and Djato (1997), Ajibefun and Abdulkadri (1999), Ajibefun and Daramola (1999), Ajibefun et al. (2002), Ojo (2003), Alabi (2003) and Alabi et al. (2004). Adesina and Djato (1997) applied the stochastic frontier model to measure, using the profit function, the relative efficiency of women as farm managers. Their results showed that the relative degree of efficiency of women was similar to that of men. Ajibefun and

Abdulkadri (1999) estimated technical efficiency for food-crops farmers under the National Directorate of Employment in Ondo state, Nigeria. The results of analysis indicated wide variation in the level of technical efficiency, ranging from 0.22 to 0.88 on a scale of 0–1.0 (indicating that the level of technical efficiency of the farmers ranges between 22% and 88%). Ajibefun and Daramola (1999) estimated the technical efficiency of industrial poultry production in Ondo state, Nigeria, while Ojo (2003) determined the technical efficiency of commercial egg production in Nigeria. Alabi (2003) investigated human capital as a source of inefficiency of cocoa-based agroforestry in Oyo state, Nigeria. Alabi et al (2004) compared the technical efficiency of agroforestry and non-agroforestry systems in Nigeria. Ajibefun et al. (2002) used the stochastic frontier production function to empirically determine the level of technical efficiency of the farmers as well as the factors that influence efficiency. In Oyo state, they found significant inefficiency effects among farmers, whose technical efficiency was in the range 19–95%.

Methodology

Area of study

The study was carried out in the Niger Delta, which is located in the southern part of Nigeria, between latitudes 4°30'N–6°20'N and longitudes 5°10'E–8°30'E. The Niger Delta embraces nine (Rivers, Delta, Cross-Rivers, Akwa-Ibom, Ondo, Bayelsa, Imo, Abia and Edo) of the 36 states of the Federal Republic of Nigeria. It covers about 105,000 km², which is about 3% of the total land area of Nigeria, and has a population of about 30 million, giving it one of the highest population densities in the country (UNSD 2001). The average population growth of the area is 3%, as against 2.8% for the rest of the country, with life expectancy of 45 years compared with Nigeria's national life expectancy rate of 57 years. The unemployment rate in the area is above the national average. About 65% of the people of the area are engaged in farming and fishing, using traditional methods. Agricultural activities in the area are also hampered by oil spillage.

Data collection and sampling technique

Data collected for this study included socioeconomic characteristics of the respondents and the inputs, outputs and incomes of family poultry

production units. A multi-stage sampling technique was employed. One state—Edo—was randomly selected from the nine states that make up the Niger Delta. The second stage was the random selection of two local government areas from the three senatorial districts that make up Edo state. The third stage was the selection of a random sample of six communities from the two local government areas. The final stage was the random selection of 20 respondents from each community. Trained enumerators were used to administer the questionnaire to the 120 respondents. Only 116 of the questionnaires returned were found to be usable.

Data analysis techniques

The information in 116 sets of questionnaires was analysed using percentage distribution and a stochastic frontier production function. The stochastic frontier production function was specified as:

$$I_n Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + (V_i - U_i) \quad (3)$$

where:

- Y = income from family poultry (₦)³
- X_1 = expenses on feeds (₦)
- X_2 = expenses on medicines/vaccines (₦)
- X_3 = income from other livestock (₦) (proxy for capital)
- V_i = random error assumed to be independent of U_i , identical and normally distributed with zero mean and constant variance $N(0, \gamma^2_v)$
- U_i = technical inefficiency effects that are assumed to be independent of V_i ; they are non-negative truncation at zero or half-normal distribution with $N(\mu, \gamma^2_u)$

If $U_i = 0$, no allocative inefficiency occurs and the production lies on the stochastic frontier. If $U_i > 0$, production lies below the frontier and it is inefficient.

Technical inefficiency model

In addition to the general model, a technical inefficiency model was defined to estimate the influence of some farmer socioeconomic variables on the technical efficiencies of the farmers. The model is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 \quad (4)$$

where:

- U_i is as defined before
- Z_1 = age of the farmers in years (years)
- Z_2 = family size (number)
- Z_3 = gender (dummy, 1 for male and 0 otherwise)
- Z_4 = index of innovation adoption (ratio of number of innovation adoption out of maximum of six specified in the questionnaire).

The parameters of the stochastic frontier production function (SFPF) model were obtained by a maximum likelihood estimation method using the 'Frontier' (version 4.1) computer program (Coelli 1994), jointly estimating equations (3) and (4).

Results and discussion

Table 1 shows that the respondents are relatively young, with a mean age of 48 years. The mean of years of schooling was nine, which indicates that the majority of respondents were educated above primary school level (primary school certificate was scored at 6 years). This level of education is high when compared with national adult illiteracy levels of 30% and 48% for males and females, respectively, in Nigeria (World Bank 2001). Illiteracy is regarded as a major limitation to technology adoption in livestock and crop production in Nigeria. A higher level of education will enable respondents to access information that will help to stimulate their production.

Family size averages eight (Table 1), which is above the recommended average of four per family in Nigeria. The large family size is relevant to family poultry raising, because family members constitute the bulk of the labour supply in family poultry production in Nigeria (Sonaiya 2000). Females constitute 58% of the family poultry producers in the study area, similar to the Sonaiya (2000) estimate of 56%. It has been demonstrated that women in rural areas of Nigeria generate most of their income from poultry (Alabi and Isidahome 2004).

Table 2 shows that the main reason for rearing family poultry is for sale. About 53% of the respondents indicated that they reared poultry for sale. Sonaiya (1995) reported that, in poor producer families, poultry products are not consumed but are mainly sold when the household is in need of cash. The income from the sale of poultry products augments revenue earnings from field-grown cash

³ ₦ = Nigerian naira; US\$1.00 = c. ₦130.

crops. Alabi and Osifo (2004) demonstrated that income from family poultry contributes significantly to the cash economies of women in Nigeria. Sonaiya (2000) estimated that the sale of poultry products contributes about 15% of the annual financial income for rural households. The information on the breakdown of the sales of family poultry in Nigeria shows that the proportions of the revenue from sales of live birds and eggs were 87% and 13%, respectively (Sonaiya 2000). The food security implication of family poultry is also reflected in Table 2, which indicates that about 39% and 6% of respondents consumed family poultry products at home and during ceremonies, respectively. Since the proteins in poultry products are biologically superior to plant proteins, consumption of these products will increase the dietary supply of essential amino acids. Analysis of the proportions of meat and eggs from family poultry consumed by Nigerians shows that meat and eggs constitute 82% and 18%, respectively (Sonaiya 2000).

Table 1. Socioeconomic characteristics of the respondents

Age (mean)	48 years
Years of schooling (mean)	9 years
Family size (mean)	8
Gender proportions	58% female, 42% male

Source: Field survey in 2003

Table 3 shows that therapeutic goods such as medicines and vaccines constituted 80% of the variable cost of the producing family poultry in the study area, while feed constituted about 20%. The costs of housing and replacement stock were excluded because the majority of the respondents did not pay for housing and replacement stocks.

Table 2. Distribution of respondents ($n = 116$) according to their objectives of rearing family poultry

Objective	Number of respondents	Percentage of respondents
Sales	80	52.63
Home consumption	59	38.82
Ceremonial consumption	9	5.92
Rituals	1	0.66
Other	3	1.97
Total	152 ^a	100.00

Source: Field survey in 2003

^a Total includes multiple responses

This cost structure is different from that in commercial poultry production where feed accounts for more than 60% of the variable cost (Alabi et al. 1999). Family poultry depend on the village environment for their feed. Free-range birds do not receive sufficient feed but survive on scavenging, spent grain and chicken waste from households with minimum cost. The estimated cost of medication and vaccine of 80% is higher than the 14% estimated by Sonaiya (2000). This may be due to the increase in prices of medicines and vaccines between 2000 and 2004 in Nigeria.

Table 3 also indicates that income from sales of live birds and eggs constitutes 79% and 21%, respectively, of total revenue from family poultry. This is comparable with the 87% and 13% for sales of live birds and eggs estimated by Obi and Sonaiya (1995) in Osun state, Nigeria. The annual average profit is ₦38,834.60 (US\$290), which is higher than Nigeria's per-capita income of \$280. The return on investment of 7.60 shows that family poultry is highly profitable. This high profitability should attract financing by lending institutions. The direct interpretation is that if a family poultry enterprise were loaned ₦10,000 (US\$74) by a financial institution, at an interest rate of 10%, the family poultry would generate ₦76,000 (US\$563). This means that the borrower would be able to return the principal (₦10,000 or US\$74), the interest of ₦1,000 (US\$7.40) and retain about ₦65,000 or US\$482 as profit.

Table 4 shows the maximum likelihood estimates of family poultry production in the study area. Maximum likelihood estimation procedure is used because it is asymptotically efficient—it is consistent and asymptotically normally distributed. Table 4 indicates a significant positive relationship between the expenditure on feed, medicine and vaccines, income from other livestock (capital) and

family poultry income. This indicates that if more feed, medicine and vaccines are given to the family poultry, they will yield a more than a proportionate increase in output. The positive and significant relationship between the income from other livestock and family poultry reflects the fact that the flow of capital to family poultry will significantly increase the income of the family flock.

The positive and significant relationships between feed, drugs and output of commercial poultry production have been documented by Ajibefun and Daramola (1999) and Nkereumem et al. (2001).

Predation by hawks is negatively related to the income from family poultry, suggesting that increased hawk attack will reduce the income from

family poultry. If the hawk attack is taken as an indication of extensiveness of the family flock, it then means that the extensive system of rearing might reduce the income from family poultry. Hawk attack was not a significant factor in this study, however.

Considering the coefficient of the determinants of the income of the family poultry in Table 4, feed coefficient has the highest value of 5.699. This means that a greater increase in income of family poultry can be experienced by increasing the feed (quality and quantity) given to the family poultry than by increasing any of the other factors that influence family poultry income as specified in this study. The importance of feed in stimulating poultry production in Nigeria has been noted by Oluyemi

Table 3. Costs and returns in family poultry production in the study area

Costs and returns	Amount (₦) ^a	Percentage
Costs		
Feed	116,163	19.6
Medication/vaccine	476,373	80.4
Total	592,536	100
Returns		
Live birds	4,041,780	79.3
Eggs	1,055,570	20.7
Total	5,097,350	
Profit	4,504,814	
Average profit	38,824	
Return on investment	7.60	

Source: Computed from 2003 field survey results

^a 130 Nigerian naira (₦) = c. US\$1.

Table 4. Maximum likelihood estimates of stochastic frontier production function and inefficiency parameters for family poultry

Variables	Coefficient	t-ratio
Constant	3.924	1.530
Expenditure on feed	5.699	4.883 ^a
Predation (hawk attack)	-1.387	-1.032
Expenditure on medicines/vaccines	5.149	4.136 ^a
Income from other livestock	2.829	3.681 ^a
<i>Inefficiency parameters</i>		
Age of the farmers	-5.648	-1.460
Family size	-4.003	-5.802 ^a
Gender	-2.714	-3.451 ^a
Index of innovation adoption	-2.098	-3.921 ^a
Gamma (γ)	0.92	27.966 ^a
Estimate of variance	32.784	5.846 ^a
Log likelihood	-288.022	
Technical efficiency (mean = 0.22)	Minimum = 0.09	Maximum = 0.63

Source: Computed from 2003 field survey results

^a Significant at the 5% level

and Robert (1988). The relative importance of feed in family poultry production cannot be over-emphasised. According to Sonaiya (2000), energy is the first limiting nutrient, as food available on the range contains a lot of crude fibre. That is why energy supplements may increase production significantly.

Inefficiency parameters show that age is negatively related to family poultry production. However, it is not significant at the 5% level. Family size, gender and index of innovation adoption have significant and negative relationships with the inefficiency of family production in the study area. This means that inefficiency in family poultry production decreases with increase in family size. This may be due to the fact that family poultry depends on the number of family members for labour and feed supply. The significant and negative relationship between gender and inefficiency of family poultry production suggests that inefficiency is lower among females than males. This may be due to the fact that women are more involved in family production than men, and have hence developed caring techniques superior to those of men. It may also be due to the fact they stay more at home caring for family poultry than men. It may also be attributed to the gentler nature of women leading to better flock husbandry. The implication of this is that women may efficiently generate more income from family poultry than men. Hence, strategies and interventions to increase women's income may consider chicken raising.

Index of innovation is negatively and significantly related to inefficiency in family poultry raising. This indicates that, as the number of innovations adopted increases, inefficiency of family production decreases. Innovation adoption has been shown to improve the productivity of farmers (Oladele and Fawole 2001). Innovations that are related to management of family poultry, such as regular watering, enclosure, vaccination, medication and feeding, can bring about a significant improvement in productivity of family poultry, as demonstrated by Ouandaogo (1990) in Burkina Faso, Bessei (1990) in Niger and Sonaiya (2000) in Nigeria.

The level of innovation adoption among family poultry producers is generally low in Nigeria, because they have little contact with extension agents (Ladele 2002). Sonaiya (2000) reported that less than 5% of family poultry producers in Nigeria had any contact with poultry extension agents. Furthermore, extension agents in Nigeria have no mandate to work on family poultry production.

Table 4 also shows that the estimate of variance parameter is 32.784 and that gamma (γ) is 0.92, close to one, which indicates that the inefficiency effects are highly significant in the analysis of the income of family poultry production in the study area. If gamma is zero, the variance of the inefficiency effect is zero and so the model reduces to traditional average response function in which the variables of age, family size, gender and index of innovation adoption are included in the production function. The log likelihood function is estimated to be -288.022. This represents the value that maximises the joint densities in the estimated model.

The predicted technical efficiency varies widely across the respondents, ranging between 0.09 and 0.63 (on a scale of 0 to 1) with a mean of 0.22. This means that the family poultry producers are 22% efficient in the use of the combination of their inputs.

The elasticity estimate (a summation of the coefficients of costs of feed, hawk attack, and medicines and vaccines, and income from other livestock) is 12.290. Since this is greater than one, it suggests that the producers of family poultry are operating at stage one in the production curve. At this stage, the marginal product of family poultry is greater than the average product. This is an inefficient stage, because increase in the use of inputs will lead to a more than proportional increase in output. This means that the family poultry producers are inefficient at their level of production and that their income and output would be improved if more feed, capital, vaccines and medicines were used and more innovations related to improved management were adopted.

Conclusion

This study shows that family poultry production is profitable, with average annual profit of ₦38,834 (US\$290) and returns on investment of 7.60. The SFPF analysis shows that feeding, capital and medication have significant and positive relationships with the output of family poultry. The result of SFPF analysis shows further that the technical efficiency of family poultry increases with increase in family size and innovation adoption, and that women are more technically efficient than men in family poultry production. The technical efficiency estimate shows that the technical efficiency of family poultry ranges between 0.09 and 0.63, with a mean of 0.22. This indicates that, on average, the

respondents are 22% efficient in the use of the combination of their inputs. The elasticity estimate of 12.29 indicates that family poultry production is taking place at stage 1 (inefficient stage) in a production curve. At this stage, an increase in the use of inputs will result in a more than proportionate increase in output. This study concludes that the output and technical efficiency of the family poultry production can be increased by the use of more feed, capital and medicine and the adoption of more innovations.

It can therefore be recommended that extension agencies should be mandated to disseminate improved technology that will stimulate family poultry production in the study area. Capital could be channelled to family poultry production through the provision of micro-credit and the formation of cooperative societies. Medicines and vaccines should be provided for family poultry production at affordable prices.

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A study in South Africa of the efficacy of a commercially obtained thermostable Newcastle disease vaccine in village chickens when administered by different routes

S.P.R. Bisschop¹, B.L. Mogoje¹ and M.M.O. Thekiso²

Abstract

Newcastle disease (ND) is a viral disease of poultry with a potentially devastating impact on both commercial and free-ranging poultry flocks. The disease is considered endemic in South Africa and vaccination is routinely practised in commercial poultry flocks. In village chickens, vaccination is not widely practised. There are several reasons for this, including difficulties in maintaining the cold chain and in the application of the vaccine to free-ranging birds.

The former problem has been partially overcome by the development of thermostable ND vaccines, most notably the I-2 vaccine developed in Australia. Because of stringent registration requirements, the vaccine is unavailable in South Africa. This study aimed to investigate the efficacy of a commercially available thermostable vaccine (Nobilis Inkhuku®) for use in rural communities in South Africa. In view of the difficulty of catching free-ranging chickens, three different vaccine application techniques were used: by eye-drop, in drinking water and in feed (maize).

Antibody titres measured on the haemagglutination inhibition (HI) test showed a small decline over 3 months after vaccination, indicating that an interval of more than 3 months between vaccinations would be appropriate for these flocks. Challenge studies showed an excellent correlation between HI titres obtained and survival after experimental challenge.

Titre group	Mean survival (%)
>3	95
1-3	47
0	23

Challenge survival rates varied between vaccine application groups and between the two study areas used. In both study areas, the overall survival rate for birds vaccinated by eye drop was slightly better than for birds receiving their vaccine via the drinking water. In the case of in-feed vaccination, the challenge survival rate was only slightly poorer than the other two routes in birds from the Northwest province, while birds vaccinated via feed in Qwaqwa showed a very poor survival rate. No unvaccinated birds survived challenge.

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Method of vaccine administration	Survival rate in Northwest province (%)	Survival rate in Qwaqwa (%)	Mean survival rate (%)
Water	86	60	73
Feed	75	10	43
Eye-drop	80	70	75
Controls	0	0	0

These preliminary results were considered most promising, especially the use of in-feed vaccination, which is simple to apply. Further work is planned to explore vaccine application techniques as well as the amount of effort rural communities are willing to put into the application of ND vaccine to their chickens.

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Husbandry improvements and a training program for smallholder chicken producers

Paul Gilchrist¹

Abstract

Newcastle disease research has shown that smallholder chicken production can be improved by saving the lives of many chickens. These additional chickens require improved care to ensure they perform well.

This paper has two parts, covering:

- techniques to improve the productivity of smallholder poultry
- short training programs about putting the techniques into practice.

Techniques

These aim to increase family food supply and income by improving genetic and environmental factors. Genetic improvement aims to use birds with higher genetic potential. Environmental improvement aims to protect birds from the elements, malnutrition and disease by providing better:

- housing
- nutrition
- vaccination
- sanitation
- husbandry
- marketing.

The husbandry techniques are identified in a table and described in narrative form. Numerous combinations of improved techniques are possible, and some preferred scenarios are suggested.

Training

Transferring the knowledge and implementing the skills can be done in a training program that sets out to:

- create awareness—why improve?
- improve production—teach skills
- spread the benefits—train others.

Introduction

Smallholder chickens are established in many cultures as a low-input, low-output part of subsistence agricultural activities. Constraints on productivity of these poultry activities have been identified, and methods of controlling the constraints have been studied.

There have been many attempts to improve chicken production in numerous developing

countries and in the words of one aid project manager I met in Kenya, ‘All poultry projects fail’. I have wondered why this attitude is held and, if it is true, why it must be so. It cannot be said that the Newcastle disease (ND) project for smallholder chickens has failed, but even it has had its problems. It is now recognised that maximum benefit from the project will be achieved if the increased numbers of smallholder chickens resulting from the use of ND vaccine can be protected against other threats to their survival.

Useful lessons can be learnt from the successful development of the high-technology commercial

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poultry industry and can be applied to the low-technology smallholder chicken sector.

There are cultural differences in attitudes to poultry care between people in developed and developing countries and the biases of each side in an aid project should be identified so that adjustments can be made.

People from developed countries often have a bias against housing chickens in cages and administering vaccines and medications to chickens. They may have a romantic picture of the happy barnyard with chickens feeding at the feet of the farmer's wife, laying eggs in a convenient location and producing baby chicks regularly.

Some people may also have negative attitudes towards larger-scale private enterprise and may consider that the involvement of commercial breeders, feedmills and equipment suppliers is somehow socially unhealthy. On the contrary, provided that there is some healthy competition, it is usual that such 'middle men' or specialist suppliers provide a worthwhile and economical service to producers.

Smallholders in developing countries may have a view that chickens are a low-cost (or no cost) part of the scene at home and that occasional eggs and chickens are a cheap addition to the diet. They may therefore be disinclined to spend money on improvements.

These attitudes encourage a view that smallholder chickens must operate on a low-input, low-output basis and can block a clear, objective consideration of ways to improve productivity.

Techniques

The categories of techniques to be considered are:

- planning
- genetic factors
- environmental factors.

Planning

Science and technology developed in commercial chicken production have some potential application in smallholder chicken production. Some choices must be made, and the planning phase is the time for this to be done.

Any smallholder chicken production project should have a planned approach to the endeavour. There are many options available, and some innovative thinking may be required to allow a response to

the needs of the smallholder. An incremental approach may be best, to allow the advantages of each level of development to be tested, appreciated and applied step by step.

The starting point for an aid project may vary from a situation where no chicken production occurs, through a scavenging, semi-feral chicken situation to some more developed production situation, perhaps with some housing, some supplementary diet and maybe some vaccination.

I am assuming that the benefits of vaccination against ND have been accepted as a clear benefit but that the increased survival rate of vaccinated chickens has led to a need to develop ways to keep these survivors alive and productive. Scavenging chickens that have been protected against ND will soon overpopulate the available scavenging resource and will need additional husbandry inputs.

The planning phase must define the existing chicken production methods and consider whether it is appropriate to seek to develop a chicken project by means of adding technological elements so as to improve things in a sustainable way.

The planner must:

- describe the baseline poultry production situation and producer attitudes
- identify and quantify the marketing opportunities for selling products
- identify and quantify the inputs required to increase productivity of chickens
- select technological improvements appropriate to the circumstances
- train trainers and participants in the project
- prepare budgets for participants (and for the donors).

The details of each of these elements are too complex for this paper, but experienced aid planners will be familiar with the steps involved. The particular genetic and environmental factors available to the planner may, however, be unfamiliar.

Market demand

Planning such a project must begin with an estimation of the availability of a market for the product and of the ability of the project participants to supply the market. This may lead the planner to suggest development of a larger or smaller number of production units. At some point, a smallholder project may become a commercial operation and require a different level of planning.

Market supply

Having identified the market demand it is important to make sure that the project can expand or contract to meet that demand.

Economics

How many projects do you know that have been found to be uneconomical after trying to set them up? A simple budget may serve to encourage or discourage you at the beginning.

The budget process is based on reducing likelihood of success and failure. Table 1 outlines the fundamental elements of cost and income that should be taken into account.

An incremental approach is suggested. Start small and, as experience is acquired, some growth may be appropriate. While it appears sensible to apply the best level of environmental protection possible, there are some constraints that suggest a more cautious approach.

First, there are economic elements that need to be explored. A simple budget exercise may help identify how much investment will support a desirable return on investment but selling such an idea to a smallholder may be difficult. People seem to learn best by making mistakes. Remember that budgeting may convince you to not start at all. It is one of the prime benefits of a budget exercise to show that a proposal is unrealistic.

Second, there is limited experience in operating some of the elements of the system and research, perhaps operational research, may be needed.

Third, there is a concept of implementation by increments. As the benefits of each scenario are demonstrated, additional improvements can then be considered. A demonstration at the commencement of the project could be advisable.

Genetic factors

Consideration of introducing improved genetics should include different species and breeds. Layer or meat chickens, ducks (including some egg-laying varieties), guineafowl, muscovies, pheasants, partridges and quail may have some application in some areas. Species vary in susceptibility to diseases and in productivity and the need for resources (e.g. ducks eat invertebrates such as water snails). Local cultural attitudes also vary.

This paper concentrates on laying-hen production, as it is the most commonly practised form of poultry production and offers the most direct means to improve output efficiently.

Chicken meat production is a rather specialised activity and appears to me to be inappropriate for smallholder production activities.

In planning a layer-chicken project, consideration may be given to the choice of various genetic materials including:

- using unselected local breeds
- using improved local breeds
- upgrading with purebred males
- upgrading with purebred males and females
- using improved crossbreds.

Improved genotypes do not perform well under scavenging (semi-feral) conditions but if provided with some critical environmental protection they can perform better than local, unimproved birds. There are sometimes perceived cultural preferences for 'local' breeds and their products, but a little budgeting will soon show that the potential for improved productivity (dollar return on dollar invested) is low with poor-producing local breeds.

Improved crossbreds may not perform well under environmental conditions prevailing in a particular locality but their greater genetic potential means that improvements in environment will permit them to express that potential. Local breeds remain limited in genetic potential and cannot be expected to respond significantly to improved environmental conditions.

Local breeds may, under conditions of good husbandry, lay 50 eggs per year, while improved commercial crossbred birds can lay over 300 eggs per year. Unimproved breeds are prone to broodiness. Broody hens lay eggs in a clutch (or batch) and then go into a pause when they do not lay. This is a natural arrangement to allow the hen to sit on her eggs to incubate and hatch them. Improved breeds are selected to have no broodiness and thus can lay more eggs per year.

In order to obtain improved genetic material, a source must be identified. As with most things in life, you get what you pay for. Commercial crossbred chickens have the best genetic potential and are expensive. Also, they need to be replaced each year or two as they are unsuitable for breeding future replacements. However, provided improved environmental conditions are provided, they can produce the best returns on investment.

Table 1. Budgeting for a layer chicken project: outline of items

INPUTS	Quantity	Cost	Total	OUTPUTS	Quantity	Value	Total
Capital							
Housing							
Fence							
Shelter							
Cage							
Equipment							
Feeder							
Nest							
Waterer							
Lights							
Egg flats							
Finance							
TOTAL							
Annual (recurring)							
Feed				Eggs			
Chickens				Cultured chickens			
Medication				Manure			
Vaccine							
Repayments ^a							
Capital							
Interest							
Transport							
Specialists							
Vaccinator							
Beak trimmer							
TOTAL							
Intangibles							
Family labour?				Insect control?			
Land rental?				Cultural benefits?			

^a Allow three years to recover the capital costs

A step-by-step process may be appropriate to allow the benefits of better genetics to become apparent to producers but a project that includes a demonstration of a few scenarios would soon show which genetic system provides the best outcome.

Environmental factors

Smallholder poultry of any genetic origin benefit from being protected from the ravages of the environment. They can be protected from the following environmental stresses:

- competition for resources (feed, space, perches, nesting sites) from other people's poultry, wild birds and animals
- atmospheric (meteorological) conditions
 - climate (the broader aspect of meteorological conditions temperature, moisture, wind velocity and barometric pressure) that prevails in a region
 - weather (the current state of the atmosphere)
- predators—human, animal, bird
- diseases
- malnutrition—insufficient or poor-quality feed ingredients and drinking water.

Good husbandry techniques can protect against all of these by providing isolation, confinement, housing, vaccination, medication, sanitation and nutrition.

There are degrees of each of these husbandry components and major planning and training objectives should identify the optimum component for any particular situation.

Isolation

Keeping susceptible birds separated from infected birds is a basic principle of disease control. The role of smallholder chickens in the spread of highly pathogenic avian influenza in the current outbreak in Asia is an important reminder of the importance of isolation. Very recently, the Netherlands government has banned the free-range system of farming due to concerns about the spread of avian influenza by migrating wild birds and now requires that all poultry be confined to secure housing.

All-in, all-out, single-age units have been adopted by the commercial industry but only after many years of sad experience with the alternative systems. Looking at scavenging chickens in a village situation may suggest that isolation is not possible but the emergence of avian influenza emphasises the

need to be creative about ways of achieving adequate isolation. The cage system described below provides a way.

There is a great temptation to avoid single-age situations because, on the surface, continuous production from mixed age groups appears to be more economical. The single-age approach requires breaks in production, with consequent breaks in income. The advantage of disease control outweighs these costs. This fact may be the most difficult point to prove to sceptical smallholders.

Confinement—housing

Confinement may vary from providing a few perches near the home, through simple overnight shelter, provision of a fenced area, moveable sheds, semi-intensive housing (shed and fence), intensive shed, to raised floors (colony cages or laying batteries).

There are many documented forms of chicken shed for small flocks but I wish to mention a variation that I have seen in operation in Solomon Islands and which is a possible solution to this problem. This colony cage system seems to have particular application for smallholder chicken projects.

Most scavenging flocks are quite small and poorly producing so I believe a small flock of good producers will supply more eggs and offer a real increase in family income as well as supplying additional food for the family.

The critical technological elements of this type of unit is that it provides confinement, bird-proofing, a raised floor and isolation. If a flock of seven hens is placed in the cage and all are replaced at the same time a year or two later there is a very effective micro-production unit combining most of the lessons learnt by the commercial industry with the special needs of the smallholder.

Seven hens with the genetic ability to lay 300 eggs a year may lay less in a smallholder situation; allowing, say, 275 eggs per year means that there should be 4–5 eggs each day.

As a smallholder gains confidence in this system, it is possible to increase the output by adding cage units in stepwise fashion and to produce enough eggs for sale.

When operated on an all-in, all-out, single-age basis, this system avoids the use of live-bird markets, as the spent hens can be slaughtered for home consumption and new birds can be purchased

from a specialist breeder who practises various disease-prevention methods.

Toxins in the environment can be kept out of the chickens and their products when birds are securely housed, preferably on a raised floor.

Scavenging hens may lay eggs in hidden places that are hard to find, resulting in shortages and old (stale or rotten) eggs being discovered from time to time. Confined hens lay where the eggs can be found and thus bad eggs are not a problem.

Egg thieves—crows, snakes, lizards, mammals, people—may also be a problem with scavenging hens.

The colony cage

A small flock of laying hens can be housed in a colony cage consisting of a cube made from six panels, each 1 m square, secured together into a cube of 1 cubic metre. The colony cage is supported on legs of 2 m length in such a way that the floor of the cube is raised to a height of 1 metre above the ground.

The cage can have sides, floor and top clad with 12 mm netting. I have seen variations with wooden or bamboo slats set 12 mm apart. The unit needs an access door, a feed container, a water container, a nest and three perches. It should be placed in a shady spot to protect the chickens from direct sunlight.

Figure 1 gives an outline of a panel used in constructing a colony cage. Figure 2 gives an outline of a colony cage and a shelter shed.

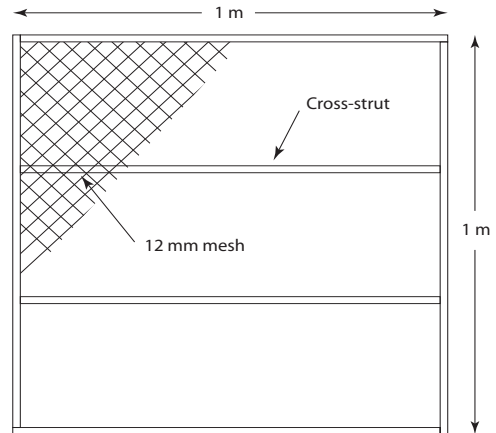
Flock size

The cage will hold seven hens comfortably. While more hens could be held in a larger cage there is no advantage in increasing the height. It can also be difficult to catch hens in a larger cage. Additional hens can be placed in additional cages that can be located nearby provided they all have the same health status.

Placement of cage

The cage must be sheltered from severe weather. A thatched shelter will usually be sufficient to exclude rain and strong sunshine. The setting sun must be kept off the shed, so some shade on the western side is needed. Shelter from the wind may be needed in some locations. Where theft is expected to be a problem, some thought should be given to security when deciding on the placement of cages.

Cages with birds of the same age and same disease status may be housed close together but 25 m separation is suggested for cages with birds of the same disease status but different age. Cages with birds of different disease status should be more widely separated, with minimum contact between them, and should preferably be separated by buildings or trees that act as a windbreak.



- The roof, floor and four sides are made from six panels, each 1 m (3 feet 4 inches) square.
- 12 mm (0.5 inch) mesh covering each panel.
- Wire on inside of cage for floor.
- Wire on outside for sides and roof.
- Two cross-struts on each panel.
- One panel to have a door inserted in lower third of panel.
- Top covered to prevent wild birds' droppings from entering.
- Western side shaded from setting sun.

Figure 1. Panel for colony cage cube

Raised floor

The raised floor separates the birds from their droppings, and breaks the cycle of infection by many organisms including coccidia and worms. It also allows ease of collection of the manure for sale or use on the garden. To prevent flies breeding in the manure, it should be removed weekly.

Single-age, all-in, all-out system

The best use of the colony cage is to place adult hens for the duration of their laying cycle and then replace them all after a thorough clean-out of the cage. Cage cleaning involves removing all obvious dirt and manure while it is still dry and then

thoroughly washing and drying everything, including equipment, with clean water two or three times. Use of disinfectants and detergents is expensive and, while useful, it is not essential in this system.

Choice of hens

Local breeds that are adapted to the scavenging life may be uneconomical in a colony cage. A higher, more predictable egg production is needed. Adult hens should be placed in the cage. The rearing of chicks is best performed at some distant location. If commercial hens are locally available they will have the best genetic potential. Point-of-lay or spent hens may be used. Spent hens are those that are at the end of their first year of commercial production. If available, they may be suitable for smallholder production, as they are less expensive than point-of-lay hens and will lay about 60% of the number of eggs expected in their first year. These commercial hens should have already received all the necessary vaccinations.

Egg production and collection

Housed hens will not hide their eggs so freshness is assured. Scavenging hens lay irregularly and will go broody and sit on clutches of eggs. Their eggs may be hidden and the age of the eggs is not known with possible rotten eggs being found. Commercial breeds do not go broody.

Breeding

Breeding, as with chick rearing, is best done elsewhere. No males are needed in the cage unless it is intended to breed.

Nest

The nest may be a simple box or a plastic drum cut to suit. It should be suspended above the floor so there is more floor space for the hens. A layer of dried grass should be placed in the nest and replaced weekly.

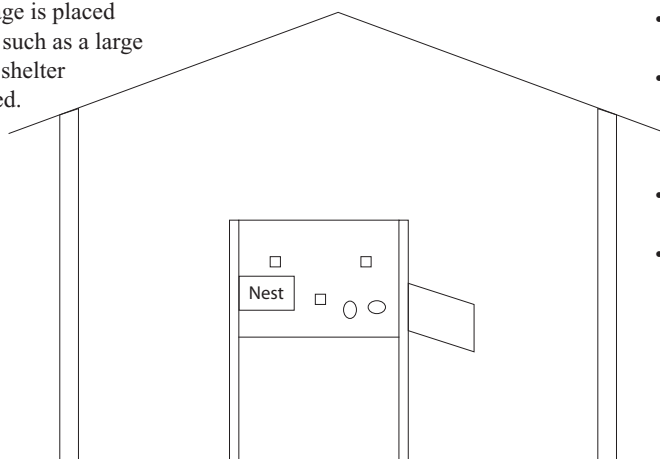
Feeders

Feeders may be of various types but should be half-filled and suspended at a hen's shoulder height so spillage of feed is reduced. Provision of feed at all times (ad libitum) is preferred if spillage is controlled. Periodic feeding leads to rushing at feeders with likely spillage.

Drinkers

Water should be available at all times. Many types of drinker are available but should be suspended at shoulder height to minimise spillage and contamination by droppings. Water must be from a clean source to eliminate the possibility of contamination by disease-causing organisms from wild or feral birds. This is particularly significant in relation to avian influenza where the virus is carried by wild waterfowl to lakes and ponds.

The colony cage is placed under shelter, such as a large tree, thatched shelter or inside a shed.



- The cage holds seven hens.
- It is set 1 m (3 feet 4 inches) above the floor, fixed to 2 m (6 feet 8 inch) posts.
- Perches are set on cross-struts.
- The cage contains a nest, a feeder and a drinker (all suspended above floor).

Figure 2. Colony cage

Materials

The materials used in construction may be any appropriate, locally available materials such as timber or bamboo but, for adequate ventilation, wire mesh must be used on the panels. The panels may be fastened to one another and to the support poles with nails, screws or tie-wire. Support poles should be 2 m long and placed so that the cage is 1 m above the ground.

Perches

Perches should be made from 50 mm × 25 mm (2 inches × 1 inch) timber struts and supported on the cross-struts of the side panels. One is suspended 30 cm (1 foot) high and two at 60 cm (2 feet) high.

Extra care

The temperament of the breed of hen must be evaluated, as cannibalism can be a problem in caged birds. If hens have not been beak trimmed before purchase they should be trimmed on arrival. The length of the toenails should also be watched and trimming may be needed.

The optimal temperature for laying chickens is between 21 ° and 28 °C. Outside this range, the efficiency of feed conversion falls off. At lower temperatures, birds use the feed consumed to maintain their body heat. At higher temperatures they have a lower appetite and cannot eat enough to keep up production.

In hot climates, the provision of some artificial lighting after dark when the air temperature has dropped allows birds to consume more feed and keep up production.

Egg production is seasonal in chickens and is dependent upon the relative length of light and dark. The period of low production occurs in mid winter. A lighting program to achieve 16 hours of light a day is effective in preventing the deleterious effect of changes in day length on egg production. This factor is important in areas distant from the equator but is less important near the equator where day length differs less.

Vaccination

The major lesson learned from the Australian Centre for International Agricultural Research ND projects is that protecting smallholder chickens from ND can increase their survival rate.

There are a number of other diseases (see Table 2) that can be prevented by vaccination. A survey of existing disease problems will indicate what vaccines are needed.

While it is always best to use vaccines prepared under strict conditions of hygiene and quality control, it is possible to use very basic vaccines for control of some diseases. Even in some quite advanced poultry industries, vaccines against fowl pox and laryngotracheitis have been prepared from infected birds.

Vaccine can be prepared by removing scabs from active fowl-pox lesions on the comb of infected birds. The scabs are ground in a mortar and pestle together with some sterile fine sand and mixed with glycerine (10 mL per scab) containing some antibiotics (penicillin and streptomycin). After settling for a few minutes, the supernatant is poured off and stored frozen. The scabs can also be air-dried and stored frozen in a dry form for many months without much loss of potency. The vaccine is applied by the skin stab method to the wing web or to the unfeathered skin of the thigh. If the vaccination has been effective, pox lesions will be evident at the vaccination site after 10 days.

Laryngotracheitis vaccine can be made from the tracheal exudate of recently infected birds. Six-week-old birds are reared in a good degree of isolation and infected by instilling a drop of infected tracheal mucus (mixed with antibiotic) into their trachea. After 3–4 days, some tracheal mucus has formed and can be collected by killing the birds, removing the trachea and slicing it lengthwise to expose the lumen. Scrape the mucus away from the lining with a scalpel blade. Mix the mucus with glycerine (10 mL per trachea) and antibiotics (penicillin and streptomycin) and store frozen. The vaccine is applied to the cloacal mucous membrane using a simple instrument consisting of a 2 mm piece of wire that is dipped into the vaccine and then rubbed gently onto the dorsal surface of the cloaca. If, after 4 days, the area of application has become inflamed with a characteristic cherry-red colour, this indicates that the vaccine has been effective.

Medication

As shown in Table 2, some diseases may require medication. The specifics of each medicine are too specialised for this paper. I have a warning about home remedies and so-called ethno-veterinary medicines. As with human 'alternative' remedies, there may be a gap between claims and reality. I trust

that Western middle-class sympathies will always take second place to the need for evidence that claims of effectiveness are true. Seek proof before accepting any claims.

Sanitation—hygiene

Some bacterial diseases may remain in the cage and equipment between batches and thus it is important to thoroughly clean everything before new birds are introduced. The hygiene process has several important steps. First, brush off any dirt, dust and droppings from housing and equipment. Then wash in warm water and detergent three times, allowing the things to dry between each wash. Finally, apply a strong solution of disinfectant foam and leave to dry. Protect from contamination by wild animals and birds until the new batch of chickens arrives.

Nutrition

Scavenging birds have a stocking density related to the available scavenging resource within the area of their home range. The resource can be extended by supplementary feeding that may range from table scraps and surplus or damaged grains from harvest time, through supplementary feeds such as grains or protein supplements, to full commercial feed.

It may be possible to prepare adequate feed from local ingredients but some expert advice is needed before doing so. Commercial feed may be in mash or

pelleted form. The latter is slightly more efficient as each bird gets a balanced ration in each pellet. Mash feeds are a little less expensive and are quite usually satisfactory for layers. Free-choice feeding is worth considering also. In this system, the hens select their own mixture of ingredients. Separate feed containers contain grain and a concentrate comprising all the other ingredients of a full ration. The chickens select the ingredients required by them for different parts of their egg laying cycle.

When birds are held in a scavenging situation there can be some advantage in ensuring that young birds have access to improved feed by supplying it in a ‘creep’. This is a system in which feed is supplied inside a small barrier with spaces small enough to allow chicks to enter but not adults.

Although many feel intermittent feeding is more economical, there is plenty of evidence that the best system is to allow feed to be available at all times. Caged birds should have access to feed (and water) at all times.

The source of water is important. Water quality should be high enough to ensure it is free from contaminants such as toxins and microbes. Avian influenza especially is transmitted in water contaminated by infected wild birds.

A correctly balanced commercial ration should have sufficient calcium in it to prevent deficiency from occurring and thus provision of an additional source of calcium, such as shell grit, should not be

Table 2. Disease control in smallholder chickens

Disease	Prevention	Treatment
Newcastle disease	Isolate, vaccinate	
Fowl pox	Vaccinate	
Infectious bronchitis	Vaccinate	
Laryngotracheitis	Vaccinate	
Avian influenza	Isolate, vaccinate	
Infectious bursal disease	Vaccinate	
Marek’s disease	Vaccinate at 1 day of age	
Mycoplasma	Buy from tested breeders, isolate, vaccinate	Medicate
Pullorum disease	Buy from tested breeders, isolate, raised floor	Medicate
Fowl typhoid	Isolate, hygiene	Medicate
Fowl cholera	Isolate, hygiene, vaccinate	Medicate
Coryza	Isolate, vaccinate	Medicate
Coccidiosis	Medicate, raised floor	Medicate
Borreliosis (fowl tick fever)	Isolate, vaccinate	Medicate
Mites	Isolate	Medicate
Lice	Isolate	Medicate
Worms	Raised floor	Medicate
Toxins	Confinement	

needed. Chickens often eat small particles of gravel or grit, apparently to assist in grinding food in the gizzard. This is not an essential function but many producers feel that supplying shell grit adds a bit of calcium to the diet and provides something in the way of grinding material in the gizzard.

Extra husbandry

Closely confined chickens are likely to pick at one another and this can lead to severe damage, usually called cannibalism. Commercial industry may control it by lowering light intensity in windowless houses but most commonly by beak trimming. There are a number of methods of beak trimming but each consists of removing the first one-third of the top, and sometimes both, beaks. Bleeding is controlled by heat cauterising the cut surface. I have seen beak trimming done in Kenya by use of a large soldering iron which combined both cutting and cauterising.

Despite views to the contrary, male chickens (cockerels) are not needed for egg production but are needed for breeding. Cannibalism is likely to be less of a problem in chickens kept in confinement if there is no male bird present.

Specialised chicken breeders usually supply commercial farmers but are, of course, happy to sell chicks to anybody. There may sometimes be a need for specialised hatcheries to hatch eggs but this function is usually carried out by the breeder organisation.

There is an advantage in buying started (or ready-to-lay) birds. These are 16–18-week-old birds that have been reared in isolation and are free from specified diseases. The advantage of the purchase of started layer chickens is that someone else has borne the cost and time of rearing, vaccinating and medicating during the 5-month rearing phase. The buyer can get just the required number of birds without providing for the normal mortalities during the rearing phase and without having facilities and resources tied up during the long rearing period.

Natural incubation can be used by the less-developed smallholder using local or purebred chickens. The special crossbred birds do not go broody and thus are not useful for natural incubation.

If a hen does go broody it can be stopped in a number of ways, including confining it in a small cage with a wire or slatted floor and no nest. The hen cannot produce a warm environment for sitting on eggs and returns to normal in a few days.

Budgeting

Table 1 outlines the expense and income items likely to be involved for a single producer in a layer chicken project.

Disease control

Table 2 lists common diseases likely to occur in smallholder poultry and the principles of control for each disease. The details cannot be dealt with in this paper.

Incremental planning

Table 3 gives the various steps in developing the elements of layer chicken production.

Training

Transferring the knowledge and implementing the skills can be done in a training program that sets out to:

- create awareness—why improve on a traditional system?
- show how to improve production—teach skills to smallholders
- show how to spread the benefits—train the trainers.

Skills analysis

This process is an effort to identify and describe the skills needed to implement the program. It is conducted by drawing up a list of the component parts or steps for each of the essential skills, confirming their relevance by consulting stakeholders and having these findings validated by experts.

For example, the steps involved in achieving competence in the skill of beak trimming are as follows:

1. explain why beak trimming is done
2. explain correct age of bird for beak trimming
3. demonstrate location of cut for beak trimming
4. explain how long cautery is to be applied
5. prepare equipment
6. catch and handle bird
7. hold bird for the procedure
8. trim beak
9. apply cautery
10. check that job is done.

Table 3. Incremental change in factors involved in smallholder chicken production

Element	Base line (entry level ^a)	Level 1	Level 2	Level 3	Level 4
MARKET DEMAND	Nil	Local	District	Agent	Integrated
MARKET SUPPLY	Feeding family	Sale of surplus eggs, chickens, manure	Increased production	Higher output	Commercial scale
ECONOMICS	Low input/low output	Small investment/return	Larger investment/return	Business level of investment/return	Expansion
GENETIC	Local breeds	Improved local breeds	Purebreed males	Purebreed both sexes	Improved crossbreeds
ENVIRONMENT					
• Nutrition	Base (scavenging + scraps)	Base + grains Creep feed	Base + grains + protein Creep feed	Balanced ration Choice feed	Ad libitum feeding—mash or pellets
• Water supply	Unsupervised	Shared with other stock and wild birds	Local storage	‘Clean’ source	Uncontaminated or treated
• Protection—housing	Free range	Fenced area	Semi-intensive Some egress from house	Intensive Closed shed No access to outside Bird-proofed	Raised floor
• Health	Nil	Newcastle disease vaccine	Sanitation	Medicines and other vaccines	Isolation
• Stocking density	Uncontrolled	Thinned periodically	Annual cull	Set flock size	
Additional husbandry					
• Age of replacement	Uncontrolled	Culled for age	Two years	Forced moulting	Annual
• Lighting program	Nil	16 hours per day	16 hours per day	16 hours per day	16 hours per day
• Husbandry specialisation	Generalists	Started layer rearing Vaccinators	Breeders Chick sexers	Hatchery Beak trimmers	Integrated
• Beak trimming	Nil	10 days of age	18 weeks of age	Two trims	Two trims
• Cockerels	Uncontrolled	Keep ‘better’ males	New male annually	No males	No males

^a ‘Level’ refers to progressive steps within each row. In a particular case, elements from one level may be combined with elements from a different level. For example, raised floor house (level 4) could be combined with improved local breeds (level 2) and a lower level of health provision (level 1).

In a smallholder situation, it is possible that most existing participants may be skilled in steps 6 and 7 but would not be competent in any of the others. This knowledge would enable the training planner to give emphasis to the other items.

This list is also used to assess a student’s knowledge and ability. Table 4 is an example of the checklist to be used for this example.

Other skills required may include:

- preparing a budget
- estimating market demand for eggs
- explaining the needs of hens for protection from the weather
- applying for micro-credit
- constructing a colony cage
- placing an order for supply of point-of-lay hens
- buying
 - feed
 - vaccine
 - medicine
- vaccinating against
 - Newcastle disease
 - fowl pox
 - laryngotracheitis
- collecting and storing eggs
- killing sick birds
- killing and dressing culled-for-age hens
- cleaning a cage between batches.

It must also be understood how to progress from a simpler to a more complex system, the reasons for isolation of laying hens from other birds and why live-bird markets are dangerous for flock health.

Gap identification

The difference between the skills required and the trainees’ skills is the training gap that must be filled by the program. For each area of skill, a list of component parts or steps must be drawn up.

Curriculum

A training curriculum should be designed to address the skills gap. Some training may be done in groups but some may need to be done on individual properties.

The methods should be appropriate to the particular skills and include the following elements:

Literature

This should be prepared in appropriate languages and include relevant illustrations.

Lectures

These may be simple but should involve the participant directly in the activity as much as possible. ‘Chalk and talk’ is an inappropriate teaching method. Participatory learning is preferred.

Exercises

Practical measures to enable participants to be directly involved in explanations and practice are needed.

Demonstrations

These are essential to the training process and may include:

- infrastructure
- technology
- operations.

Table 4. Beak trimming—list of steps and assessment of competence

Date..... Candidate..... Assessor.....

No.	Step	Y or N	Comment
1	Explain why beak trimming is done		
2	Explain correct age of bird for beak trimming		
3	Show location of cut for beak trimming		
4	Explain how long cautery is to be applied		
5	Prepare equipment		
6	Catch and handle bird		
7	Trim beak		
8	Apply cautery		
9	Check that job is done		
10	Explain how long the effect will last		

During the training sessions, it should be possible to identify participants with leadership potential and those with the ability to become trainers of future participants.

The whole enterprise must be subject to regular monitoring in order to identify problems and thus suggest needs for research or for changes to infrastructure.

Conclusion

To maximise the proven benefits flowing from ND vaccination of smallholder chickens, it is necessary to improve their situation by offering them protec-

tion from other diseases, the environment, competitors and predators. Providing the chickens with confinement, improved nutrition and adequate housing can do this.

It is possible to move from a scavenging smallholder chicken operation by adopting the principles of good poultry husbandry as applied in the commercial chicken industry. An incremental approach is proposed, with the use of an isolated colony cage system being the optimal system.

Operational and other research projects will be needed to adapt the recommended approach to situations existing in various geographical and cultural situations.

Tools for effective dialogue with smallholder farmers in Togo

Charles E. Bebay¹

Abstract

Crop and livestock production is the mainstay of 70% of the population of Togo, and traditional poultry production is a big part of this. Poultry—in order of importance, chickens, guineafowl and ducks—number about 7 million. More than 70% of Togolese farmers have birds. The main diseases affecting poultry are Newcastle disease (ND), fowl pox, Gumboro disease and parasitism. A system of community livestock workers and associated community drugstores introduced to combat ND failed. Details of the system are given and reasons for its failure suggested. Local radio was found to be an effective way to disseminate information about better practices for village poultry raising and could be a useful tool to improve farmers' marketing practices. Poultry development had a variable effect of the role of women in village chicken production; in some places enhancing it, in others the opposite. Marketing remains a weak link in efforts to improve smallholder poultry production and its contribution to food security, nutrition and poverty reduction in Togo.

Background

Togo is a West African country with a land area of 56,000 km². It is bordered in the north by Burkina Faso, in the east by Benin, in the west by Ghana and in the south by the Atlantic Ocean (Figure 1). The country is usually divided into five regions, which are, from north to south (cities are in brackets): Savanes (Dapaong), Kara (Kara), Centrale (Sokodé), Plateaux (Atakpamé) and Maritime (Lomé, the capital).

The Togolese population is estimated at 5 million and its annual growth rate is 2.3%. The country is one of the poorest in the world, ranked 141st by the United Nations Development Programme (UNCP) in 2002. According to the UNDP, 72% of Togolese are poor and 57% of them are very poor. The urban population doubled during the past 25 years.

The average annual economic growth rate was 1.2% during the past 6 years. This severely degraded

macro-economic circumstance has been coupled with political instability since the 1990s. Women, children and disabled people are the most affected and penalised.

Crop and livestock sectors in Togo

Climatic conditions are suitable for a large range of tropical crop production in Togo. The rainfall situation is potentially very good for agricultural and livestock activities. The yearly average has been 1,100 mm during the past 25 years.

The main crop products are:

- cotton and coffee for export
- maize, rice, sorghum, yams, cassava, peanuts and beans as food crops.

Crop and livestock production is the mainstay of 70% of the population. The last agricultural census, carried out in 1996 with Food and Agriculture Organization of the United Nations support, reported that:

- only 25% of farmers are contacted by extension agents
- fewer than 3% of them used improved seed

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- 86% of agricultural areas are farmed using traditional means
- only 13% of rural households usually have access to credit.

Most of farmers are smallholders with less than 1 hectare of farmed land. Soils are being ruined because of intensive husbandry, principally in cotton-production areas.

Agricultural production contributes 40% of Togo's gross domestic product (GDP). The growth rate in food-crop production fell from 4.8% in 1985 to 1.2% in 2003, and investment in the rural sector as a whole fell over the past decade—from FCPA11

billion² in 1990 to FCPA2 billion in 2003 (World Bank 2003).

Cotton is the primary export crop and represents the country's second-highest export income earner (20%) after cement. Despite improved organisation, export crops produce only 10% of agricultural GDP, whereas livestock produces 14%. Cotton, cocoa and coffee production are falling.

Donors have strongly reduced their contribution in the rural sector. International cooperative relations are still led by the European Union (EU), despite its opposition to Togo's non-democratic political system.

Livestock

Generally speaking, Togo is not a country with a strong commercial livestock production sector. Livestock production is conducted by smallholders, usually at subsistence level. Some details of the livestock sector follow.

- There is a modest cattle population of 200,000–300,000 animals. Tropical diseases like rinderpest, trypanosomiasis, anthrax and tick-borne afflictions are the main constraints. There is no extension program to develop meat or milk production. Only the EU finances a disease control project (focusing especially on transboundary diseases).
- The sheep and goat population is approximately 200,000. Its circumstances are similar to those affecting cattle.
- The pig herd has fallen significantly since 1997 because of African swine fever (ASF). There are now fewer than 100,000 animals compared with 500,000 before arrival of the disease. There is no national plan to eradicate ASF and it has spread all over the country. Pigs are traditionally raised by women, whose socioeconomic situation has deteriorated sharply since 1997.

Traditional poultry production is age-old in Togo. Poultry—in order of importance, chickens, guinea-fowl and ducks—number about 7 million. More than 70% of Togolese farmers have birds. The main diseases are Newcastle disease (ND), fowl pox, Gumboro disease and parasitism.



Figure 1. Outline map of Togo and adjacent countries of West Africa

² FCFA = Franc Communauté Financière Africaine; 1 € = c. 666,000 FCFA

National production of livestock covers 60% of the country's requirement. The balance is provided by importation from Europe (chicken meat) and live cattle from Burkina Faso and Niger. European chicken meat is very competitive because it is mostly sold packaged while local production (commercial or traditional) is sold as live birds.

Livestock production is mentioned frequently in official documents. MOA (2004) specifies that actions in support of livestock development should aim at chickens, small ruminants and pig production for poverty alleviation and food security.

Chicken livestock system

The traditional poultry sector consists of free-ranging birds and makes up 90% of the national chicken flock. With few exceptions, birds are generally raised by women in an extensive production system, as found in other developing countries and characterised by scavenging with occasional food supplementation, natural incubation and small flock sizes.

The principal roles fulfilled by traditional poultry and poultry production are:

- to contribute to household food security
- to generate income that is used for medical expenses and to pay children's school fees
- to provide gifts for visitors, as a mark of respect.

During the past 10 years, the Togolese government reformed livestock services by redefining the role of public services and admitting private veterinary services. The number of private veterinarians grew from 1 in 1991 to 45 in 2004. The private sector now represents 50% of veterinarians registered by the national veterinary board. Meanwhile, non-government organisations (NGOs; primarily *Vétérinaires Sans Frontières France*) built up an effective delivery of livestock services by training community livestock workers.

The community livestock worker system as a first stage for Newcastle disease control

The strategy used to deliver livestock services was to train villagers to provide animal health care as community livestock workers (CLW). The training program includes poultry health care, community capacity, livestock sensitisation, health care and information on zoonoses. The criteria usually used

to select CLWs are: married, live in the village, and have a minimum education in French (courses are delivered in French).

The education program also includes food crop production techniques such as natural fertilisation by biological means. Today, Togo has a national network of 1,400 CLWs.

After a public debate that concluded in 2004, there is now a law that describes the skills, the methodology of education, the level of study of trainers and a follow-up strategy for control and training of CLWs.

Trainers are private veterinarians, agents involved in extension programs for rural development, and public-service veterinarians. The duration of the training is 7 days.

The vaccine used against ND is one adapted for village conditions (heat resistant and cheap). The price for 100 doses is FCFA2,700 (the price of two guinea fowl). The CLW takes a profit from vaccinating and from other drug sales (especially antiparasitics). The annual average income per CLW generated by livestock healthcare is FCFA60,000 (the annual salary for a rural Togolese is FCFA200,000).

A study took place in 2003 (CEFRAP-VSF 2003) to determine whether or not people have similar expectations of the characteristics of a good CLW. Different groups (except CLWs) were invited to give their opinion about the requirements to be a good CLW (Table 1). Questions were asked of those who were familiar with CLW activities.

The results show that priorities depend on whether the respondent is a farmer, a private veterinarian or a public-service veterinarian. Farmers focus their requests on CLW skills and accessibility (live in the village, selected by the community and having skills in other animals) while veterinarians extend CLW skills to those that are necessary to control their activities (have close relations, importance of education level).

Lessons learnt

Lessons learnt from the survey were that:

- the conditions for CLW selection should be adhered to
- CLW training should be extended from poultry to pigs, cattle and small ruminants because smallholder farmers usually raise those as well

- trainers of CLWs must come from different services and they must have different skills (private veterinarians, extension agents, public-service agents etc.)
- CLWs should be guided to form groups in order to facilitate their relationship with the public service, veterinarians and farmers.

These results have helped to redefine the curriculum of CLW training and to set up procedures to control their activities.

Drug provision system for community livestock workers: lessons from an unsuccessful experience

A national program for small-scale livestock production took place between 1992 and 1998. It aimed to help smallholders to improve livestock production in order to assure rural households of food security, enhance income-generating activities and reduce poverty. *Vétérinaires Sans Frontières* (VSF) was a partner in the program.

In order to continue VSF experience in implementing a local livestock healthcare delivery, the program initiated a system by which communities could easily access drugs if they had a CLW. A total of 300 community drugstores (CDs) were implemented in Togo's northern regions (Savanes, Kara and Centrale regions), which are the most productive in traditional poultry.

The main objective of the CD was to facilitate the task of CLWs by providing the basic drugs needed, particularly for CLWs living far from main roads.

The program carried out the CD system as a gift for the village community. The following preconditions were set:

- The CD would be managed by a CLW.
- The CLW CD activities would be controlled by two committees—a committee of control and a committee of management, both of which would meet monthly. The role of the management committee was to ensure that the official selling and purchasing system was applied. The control committee's task was to check that all expenses were legitimate.
- The first drug supply was donated by the project. Further CD supplies had to be provided by resources from CD operations.

Two years after implementation of the CD program, a study was made of its operation (Bebay et al. 2000). Information was collected from three sources, as follows:

- A questionnaire was circulated to 60 CDs in two regions (Savanes and Centrale)—the results presented here concern only 12 of them, but the trend was the same for all CDs.
- Discussions were held with CLWs and various members of the committees involved.
- A general survey was conducted in association with the program's field operations.

Table 2 details the questions the study sought to answer and Figures 2–5 the distribution of responses.

CDs were supplied with drugs for chickens, small ruminants and cattle (Figure 2), although CLWs are not trained to care for small ruminants or cattle. CLW skills have not been entirely taken into account.

Table 1. Survey respondents' expectations of a good community livestock worker (adapted)

According to you, what is a good community livestock worker?	Farmers (%)	Private veterinarians (%)	Public-service veterinarians (%)
Be a poultry producer	50	100	94
Chosen by the community	85	80	63
Live in the village	100	80	94
Be married	60	60	69
Importance of education level	24	60	83
Have close relations with veterinarians and public service, produce reports for them for evaluation, supervision and monitoring	3	10	100
Be of good moral standing	70	75	–
Have skills to treat small ruminants, pigs and cattle	100	30	5

Table 2. Information sought in the study of community drugstore (CD) functioning

	What we wanted to know	Parameters
When the CD started	Were community livestock worker (CLW) skills considered when we supplied the CD? Was the CD accessible to a CLW in terms of money?	Drugs class Global value of the CD
After 2 years running	Were smallholders' drugs requirements correctly considered (quantity and quality)? Were CD financial operations well conducted? Were the two committees managing and controlling CD operations effectively?	CD most- sold drugs CD less-sold drugs CD debts CD funds Number of different meetings of committees

Drugs held by CDs were predominantly antiparasitic (skin or oral route) formulations (Figure 3). Only antiparasitic drugs were held for small ruminants and cattle drugs. CDs held no vaccines because vaccination had been abandoned in favour of personal business by the CLW.

Values of CDs differed, for no logical or identifiable reason (e.g. number of smallholders, chicken population, CLW experience etc.). The average value of a CD was FCFA210,000 (Figure 4); more than a Togolese farmer's annual income. We are convinced that the value of CDs was too high.

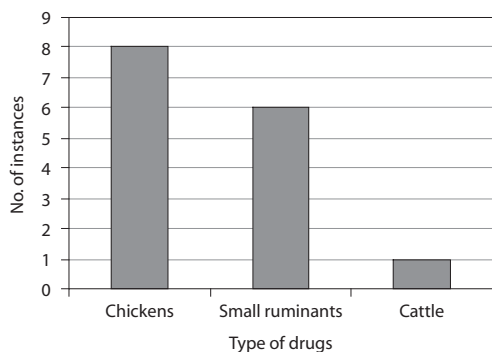


Figure 2. Livestock species serviced by community drugstores

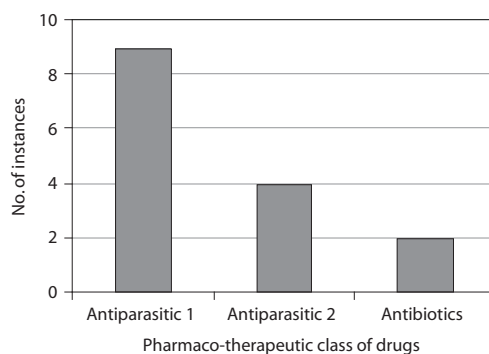


Figure 3. Therapeutic classes of drugs held by community drugstores (antiparasitic 1, skin route; antiparasitic 2, oral route)

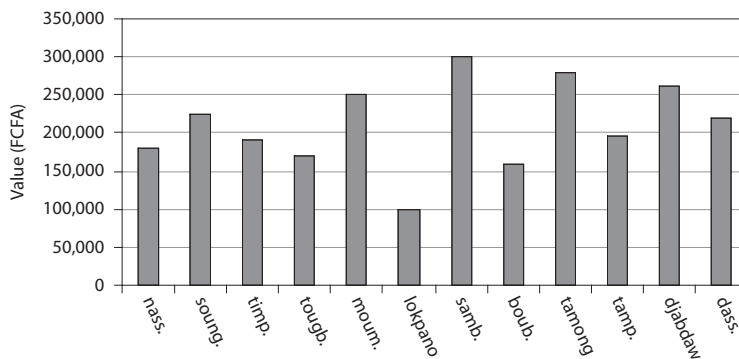


Figure 4. Value of community drugstores (in Franc Communauté Financière Africaine; 1 € = ca FCFA666,000)

Losses, debts and funds were calculated in relation to initial CD value. 1. Losses are unrecoverable debts and outdated drugs. 2. Debts are monies that smallholders should pay to the CD. 3. Funds are monies hold by CLWs plus banked funds. Profit in drug selling traditionally ranges from 20% to 50%. So a CD could be considered in a catastrophic situation if losses plus debts are greater than 30%.

The financial situation of eight of the CDs was disastrous after 2 years (Figure 5). Most of them were not able to guarantee further drug supplies, because they had insufficient funds.

Committees were supposed to meet monthly. While the number of meetings may be taken as an indicator of their performance, the financial situation of the CD must also be taken into account.

What can be deduced from the results in Figure 6 is that committees were largely inoperative. A second point is there is no linkage between the financial position of a CD and the activity of its committees. The committee of control of the

Dassoutte CD, for example, held 24 meetings, but its financial position was worse than that of the Nassiette CD.

These results led us to question the capability of committees to help CLWs in managing CDs.

Lessons learnt

1. The global value of CDs was high in terms of money and quantity of drugs. CLW management capability was not enough to ensure their sustainability.
2. The CLW had no profit from CD operations. In our opinion, this was a mistake because the experience added two conflicting notions of interest: personal (the CLW is paid by farmers when vaccinating against ND) and general (the CD is owned by the community). People involved in CD management have no interest in its success. That is why the committees failed.

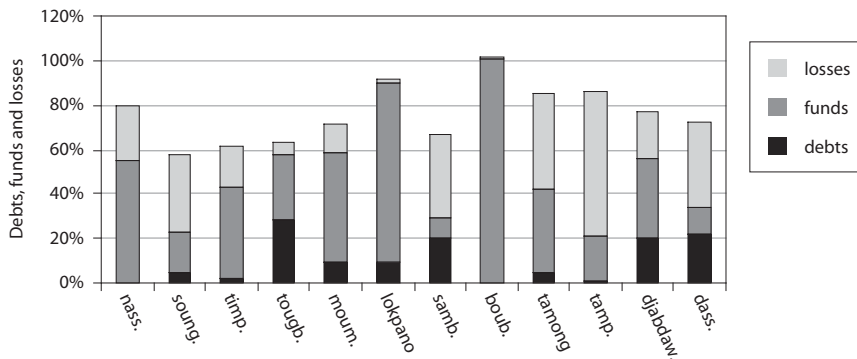


Figure 5. Financial status of community drugstores after 2 years of operation

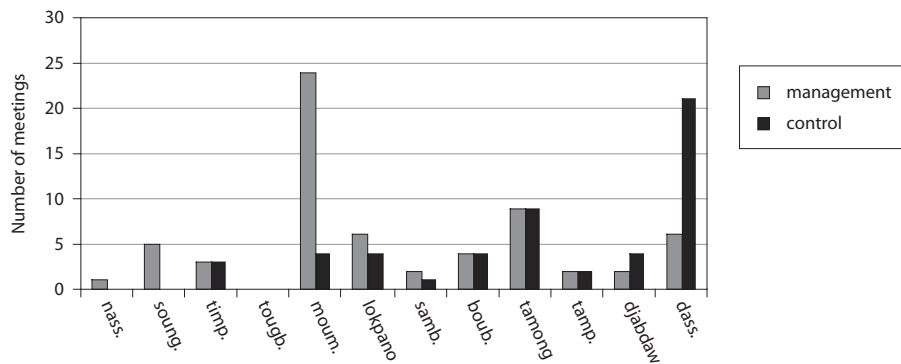


Figure 6. Functioning of committees

3. Drugs were given to the community as a gift at the end of the project and there was no system of support in terms of management.
4. Drugs could have been provided by a veterinarian via a credit system. This would likely have helped the CD to better manage credit given by the CLW to farmers. However, cash payment for drugs was expected; meanwhile, the CD managers gave credit although they were not supposed to. This created a fatal break for CD funds. For sociological and marketing reasons, we should have provided credit.
5. Farmers felt that those involved in CD management owned it. This led to envy and some of them came into conflict with the CLW, then refused to allow them to treat their birds.

Rural radio: an effective tool to train smallholders

In collaboration with a local NGO (Promotion et Action des Femmes pour le Développement), rural radio was tested as a tool for extending good practices in rural poultry development. The experience involved four local radio stations (Table 3) in the Centrale region and took place between September and December 2003.

Rural radio was seen as a potentially effective tool to train smallholder farmers in poultry development because:

- generally speaking, a radio can be found in almost every rural family
- rural families listen to the radio all day long, during their daily tasks
- most medium-size cities now have their own local radio station
- radio stations broadcast in several languages and most programs are broadcast in local languages.

Part one: production and broadcast of taped documents

Documents were written in the three languages—kotocoli, kabye and tchamba—that are the most used in the region. Programs were recorded in villages. Skilled farmers were invited to speak to fellow farmers in the local language. A fourth version of documents was written in French.

Trainers were invited to present the programs. They talked about their own experience in terms of resolving common problems in village poultry production (vaccination against ND, other treatments, improved housing, flock management, daily tasks, feeding, brooding system, management of day-old and young chickens). There were 10–20 people (men and women) for each recording. Each radio station prepared one program, then tapes were exchanged between them. Stations broadcast each tape four times, between 6 and 7 pm.

Part two: assessment

Thirteen villages of 118 receiving radio coverage were selected for assessment of the broadcast radio programs. These villages had no previous experience of poultry development activity. So we estimated that people were likely to be unaware of poultry development principles. Ten people per village (7 men and 3 women) answered a questionnaire (Table 4).

Lessons learnt

Radio is a useful medium for disseminating information on ND control. Radio messages made a big impression on farmers and could be a good means to prepare for intervention in villages.

Table 3. Characteristics of the radio stations involved in disseminating information on good poultry practices

Name of the radio station	Administrative division	Radio broadcasting range (in km)	Number of villages covered
Cosmos	Prefecture de Sotouboua	60	65
Jeunesse	Prefecture de Tchaoudjo	25	25
Espoir	Tchaoudjo	125	25
Tchamba	Prefecture de Tchamba	35	28
Total			118 ^a

^a Some villages are covered twice

Table 4. Results from the survey of listeners to radio broadcasts about poultry development

Préfecture	Listening rate (%)	Improved house-building principles (%)	Daily tasks in poultry production (%)	Measures during an outbreak (%)	CLW ^a role (%)	Vaccine cost (%)	Things listeners would like to hear about	What listeners appreciated	What listeners did not appreciate
Sotouboua	91	28	56	76	94	87	Small ruminants health care, housekeeping (how to build housing)	Use of local language, the fact that interviews were made with fellow farmers	Short time of document, use of French language
Tchaoudjo	89	35	65	83	91	78	Small ruminants health care, housekeeping (how to build housing)	Use of local language, the fact that interviews were made with fellow farmers	Short time of document, use of French language
Tchamba	98	16	63	67	88	77	Small ruminants health care, housekeeping (how to build housing)	Use of local language, the fact that interviews were made with fellow farmers	Short time of document, use of French language

CLW = community livestock worker

Women’s role in poultry production: varied local realities

A comparison was made of the role of women in village poultry production, before and after dissemination of poultry development information (Table 5).

What we can say is that, in Savanes region, improving traditional poultry production has a negative effect on leadership by household women. As poultry production becomes commercial, men keep women away from important management decisions. There is no arrangement between men and women in using income from poultry production.

In the Kara and Centrale regions, women’s leadership increased and there is an arrangement between men and women about income use.

The situation in the southern regions has not changed. Women keep money for their own business, but they use money for expenses that are traditionally men’s.

Enhancing an effective marketing system: a way to scale up traditional poultry production

Despite the improved practices that have been implemented since the beginning of the program, smallholders have not yet integrated systematic

commercial practices in terms of selling birds in Togo (Table 6). Most of them are still keeping chickens in their courtyard, expecting to sell them only when they need urgent expenses. Reasons for this are that:

- they do not wish to have a lot money at once because they fear thieves and envy
- they are proud to have a large number of birds
- they fear disease
- according to them, if they sell too many birds at the same time, the price will fall.

This is not the most profitable management strategy, because birds are kept and fed for too long. Costs incurred by the long stay are not reflected in the sale price, which is fixed by the market. The situation is worse when the bird population increases and competes with humans for cereals.

Means to boost income from poultry production and sales could include:

- encouraging networks between producers and marketers in order to improve business relations and induce producers to sell when the bird is ready
- providing market information (rural radio could be a good means to this)
- linking producers with local savings banks in order to facilitate credit access to them after deposits of savings from income generated by poultry production.

Table 5. Comparison of tasks associated with village poultry production before and after introduction of good practices in traditional poultry production

Region	Before	After	Results
Savanes	Feeding, selling chickens	Feeding, looking for maggots or termites	Women’s leadership decreased
Kara/Centrale	Feeding, deciding when to sell chickens	Looking for maggots or termites, feeding, deciding when to sell chickens, selling chickens, deciding whether to eat chickens, deciding whether to vaccinate chickens	Women’s leadership increased
Plateaux/Maritime	Feeding, deciding when to sell chickens, selling chickens, deciding whether to eat chickens	Looking for maggots or termites, feeding, deciding when to sell chickens, deciding whether to vaccinate chickens, selling chickens, deciding whether to eat chickens, deciding to introduce a new cock	Women’s leadership is the same

Table 6. Summary of the strengths and weaknesses of traditional poultry marketing in Togo

Type of birds	Products frequently sold	Marketing strengths	Marketing weaknesses	Possibility of marketing or production strategy to scale up the production and increase smallholder income
Chickens	<ul style="list-style-type: none"> • Young hens • Cocks 	<ul style="list-style-type: none"> • Frequently used for traditional ceremonies • Most eaten • Resistant during a trip, principally against heat 	<ul style="list-style-type: none"> • Low weight 	<ul style="list-style-type: none"> • Enhance the weight with feed supplementation or with a heavier cock • Possibility to sell young and old chickens
Guineafowl	<ul style="list-style-type: none"> • Eggs • Male and female 	<ul style="list-style-type: none"> • Significant market value 	<ul style="list-style-type: none"> • Fragile when the trip is long during hot season • Seasonal production • Eggs are hard to keep and transport 	
Local turkeys	<ul style="list-style-type: none"> • Male and female 	<ul style="list-style-type: none"> • Significant market value 	<ul style="list-style-type: none"> • Very customer based (price and taboo) 	<ul style="list-style-type: none"> • Target fast-food makers and restaurants • Slaughter and sell in parts.

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Thirty years of fighting Newcastle disease in rural poultry in West Africa

E. Fermet-Quinet¹

Abstract

Control of Newcastle disease (ND) is of major importance for rural poultry. Since 1978, French Cooperation and Veterinaire Sans Frontières-France have used a commercial inactivated vaccine (ITA-NEW) adapted for village use. This led to an estimated 15 million vaccinations annually in West Africa. This vaccination relies on private veterinarians, trained farmers, full-cost recovery and massive radio broadcasting of the campaign, with an immense benefit for rural poor and very little public funding. Burkina Faso, Mali and Togo could be considered as reference cases for Africa.

In 2005, Inter African Bureau of Animal Resources of the African Union started to disseminate this methodology in East Africa. It was confronted by the weakness of support policies for both private veterinarians and rural radio networks. Nevertheless, ND vaccination in rural areas has played an important role in the building of the private veterinary network in West Africa.

There is an urgent need to launch a continental pan-African ND control campaign using West African experience, as well as a requirement for continuing research for a new live vaccine to assist in the control of the disease.

Introduction

Rural poultry development programs started in the 1950s in Africa with various aspects targeted for support, including genetics, feed, shelter and marketing improvement. By ignoring the Newcastle disease (ND) epizootic and the importance of its control, these programs widely failed. This contributed to an undermining of interest of the development agencies in rural poultry and the promotion of industrial poultry production.

In 1978, a pilot program of French Cooperation, the Programme de Development de l'Aviculture Villageoise (PDAV), started in Burkina Faso with a commercial, inactivated ND vaccine specially packaged for the rural poultry of poor farmers. The

success of this program led Vétérinaires sans Frontières (VSF), a non-government organisation (NGO), and French Cooperation to disseminate it to almost all of West Africa and parts of Latin America and Asia.

The Burkina Faso pilot action

Rural poultry production was identified as a major possibility to provide fast income generation and food security for the rural poor. As ND was a major constraint to this production, the PDAV established an agreement with the veterinary drug distributor Laprovect to adapt the bottling of the Italian vaccine ITA-NEW, which was already known for its relative thermostability. The PDAV tested a 100-dose bottling under the following conditions:

- a unique intramuscular injection of 0.5 mL each year about 2 months before the regular outbreak season

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- a global recommendation of vaccination of every chick at 2 months of age
- distribution of the vaccine by the veterinary services, storing it in a refrigerator at district level
- the vaccination to be done by a trained farmer in each village, storing the vaccine in humid sand jars for a maximum of 3 weeks
- a massive radio broadcast campaign promoting ND and ITA-NEW
- a local and national competition for vaccinating farmers.

In the 1980s, the PDAV maintained an average vaccination number of 2 million chickens per year. The success of this initial program led VSF and French Cooperation to extend such vaccination programs over virtually all of the rest of West Africa (i.e. Togo, Benin, Côte d'Ivoire, Mali, Senegal and Niger).

Reference cases in Africa

Different strategies have been applied to the particular circumstances in each country, but three countries can be selected to exemplify factors contributing to the success of the program:

- Burkina Faso for its leading and initiating role, its research and development findings on rural poultry, and its development of policies and programs for small-scale rural village animal production
- Togo for its unique national rural poultry policy involving private veterinarians for distribution and training, farmers for vaccination, and VSF for technical consulting
- Mali for its very rapid pick-up and sustainability of ND vaccination.

The Mali case

Before 1994, there was virtually no ND vaccination in Mali. Starting with a local program in Sikasso region (2,000 villages), it expanded to 1 million vaccinations in 1995, 2 million in 1996, and more than 3 million in 1997 when the support program finished. The training was extended to other regions from 1998 to 2001. From 1998, private sales of the ITA-NEW vaccine by rural veterinarians have oscillated between 3 and 6 million doses. Some sales to Côte d'Ivoire and Burkina Faso were reported. During the same period, fair competition of new

laboratories, unfair competition of a few public programs, and fake vaccine were periodically developed, showing that the ITA-NEW vaccine had become of economic interest.

The Mali program relied on full and immediate private sector involvement, no subsidies for the vaccine and training of the farmers by private veterinarians. The public funds were used only for training materials, training of veterinarians, radio broadcasting and posters (one in each of 5,000 villages), and a competition for trained farmers and veterinary trainers. During the first 3 years of the campaign, the direct payment of the private veterinarians for training farmers and extension at the village level appeared to be extremely cheap and efficient compared with public-service or NGO delivery of these services, which would cost from 10 to 100 times more. Up to now, sustainability has been maintained by fully private initiative. It is a concern not to see any public support for permanent provision of basic information on the importance of ND vaccination. Mali has an estimated 20 million rural poultry.

Tracing the costs, benefits and sustainability

Field data collection and analysis made in the project reports from French Cooperation and VSF France in West African countries led to the following estimates:

- the average cost of a vaccine dose for a poor poultry farmer is around €0.1
- the average benefit for the farmer is estimated to be €2–10 per year per dose, depending on rural poultry marketing conditions and the global epidemiological situation (including vaccination rate)
- the annual national public budget necessary for training and promotion is in the range €5,000–30,000 for the first 3–5 years. Less than €5,000 per annum is needed to maintain public awareness.

The benefits to the national economy (both internal production and export), to food security and to income generation for the rural poor, especially women, are well documented by English-speaking authors.

Program sustainability relies entirely on the existence and involvement of a private veterinary

network, not only for vaccine distribution, but also to adapt to the evolving circumstances surrounding rural poultry production. After successful control of ND, other problems occur at lower intensity and on a more individual basis. To solve these does not require a special or massive campaign, but could be solved by some extra training of veterinarians. In fact, the ND vaccination campaigns have contributed much to establish and reinforce the private veterinary network (secure activity and revenue, field contacts and training).

Dissemination is promising in East Africa, but is limited by structural constraints

In 2001, French Cooperation funded the program called 'Regional action for livestock in East Africa' (RALEA) in Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Somalia, Sudan, Tanzania and Uganda. This program was devoted to regional common action related to poultry and dairy production. It was executed by the Inter African Bureau of Animal Resources of the African Union (AU-IBAR). Preliminary studies showed that, in all the countries except Tanzania, there was practically no ND vaccination of the estimated 200 million rural poultry, while at the same time 15–20 million vaccine doses were being sold in a sustainable way to the poor farmers of West Africa. As the main task of the African Union is to contribute to African continental integration, it was decided to transfer experience from West to East by editing an interactive CD-ROM and starting extension with the agreement of national authorities.

A first version of the CD-ROM is available. It contains, in three languages (French, Arabic and English), a reference methodology, a technical guide for veterinarians (rural poultry field medicine, training of farmers, autopsy), a technical guide for farmers, radio messages, and posters and pictures. The farmers manual allows production of an adapted national version: editors can insert any national language for literate farmers, and replace pictures with those of their own countryside.

In 2005, RALEA started training of private veterinarians in Burundi, Kenya, Rwanda, Tanzania and Uganda. It was intended to extend training to Ethiopia, Eritrea and Sudan in 2006. This training has been performed by West and East African consultants who noted the high interest of private veterinarians. There are, however, two major constraints to any animal production development strategy in East Africa:

- the weakness of national support to private veterinary networks—they are confronted with unfair competition favouring merchants, public service programs, and NGOs promoting second-hand systems
- the lack of a network of local radio stations in rural areas considerably increases the cost of extension. In some East African countries, a first estimate showed that the cost is 10–70 times higher than that in West Africa, where radio is a primary extension tool.

Recommendations: to pledge for a coordinated pan-African fight against Newcastle disease

As a first step, the AU-IBAR CD-ROM must be improved by adding new data, more detail on methodology and its adaptation to local sanitary contexts, better and more translations, and better functionality.

As a second step, the AU-IBAR could raise a priority fund for pan-African control of Newcastle disease in rural poultry. Experience from the campaign in West Africa indicates that an annual budget of €1 million for 5 years would be sufficient.

As a third step, a coordinated pan-African research program on rural poultry must target priorities such as further research on live vaccines to achieve ND control, on adapting vaccines for control of emerging diseases in rural poultry (Gumboro disease, fowl pox), and on characterising local poultry breeds to protect biodiversity.

Improving resource-poor households' participation in the adoption of poultry production innovations

Harry Swatson¹, Siyabonga Mazibuko¹ and Bonaventure Byebwa²

Abstract

Improving household protein food security and livelihoods in resource-poor areas will require the introduction and adoption of innovative ways of raising chickens. A study was conducted to determine the impact of promoting smallholder poultry development amongst poor communities. The objectives were to identify educational strategies associated with the adoption of poultry production and how farming households determined what course of action to take to improve upon their productive process. In general, individuals in households lacked the required economic or market-related information on family poultry production. This had an adverse impact on the way they adopted new ways of rearing chickens on a commercial basis. Decisions were based on an assessment of the cultural, religious and socioeconomic usefulness and on observable results from other experienced farmers. Information and communication networks had a great impact on the adoption decisions of respondents. Very few individuals made use of a variety of information sources before and during the adoption of a decision on how to keep chickens profitably. Reliable sources of information played a critical role in promoting the adoption of poultry knowledge and practices. Besides extension workers and 'consultants', farmers preferred their own experiences and knowledge. It has become evident that there is a need to give sufficient recognition to the value of local agricultural knowledge. Interactions with other experienced farmers in the community tended to improve farmer skills and knowledge in poultry production. This background calls for the development of approaches and methodologies to facilitate the involvement of rural households at all stages of project initiation, development, implementation, and monitoring and evaluation. This will ensure that households are able to either do away with inappropriate technologies early in the evaluation process, or adopt promising poultry production technologies.

Introduction

In South Africa, primary agriculture permanently employs approximately 800,000 individuals and

600,000 individuals seasonally on about 75,000 farming units with 8–16 people per unit. Total employment in the informal sector on small-scale and subsistence farms is approximately 1.7 million. About 7–12% of all poultry farm workers are unionised, with more than 78% of all farm workers being illiterate. Local poultry knowledge is based predominantly on practice and past experience. There is a critical shortage of agricultural scientists, especially poultry scientists and extension workers who have practical knowledge of smallholder poultry-rearing techniques. Most commercial farms are located in

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rural areas and 98% of these breadwinners or their families keep small- to medium-size flocks of chickens. The productivity of local breeds of poultry can be improved through better poultry husbandry practices, improved genetics and the creation of a niche market for poultry products. There is very little evidence to indicate many rural/peri-urban farming households intensively raise large numbers of hybrid broiler and layer exotic chicken breeds. Where broiler chickens are kept, this is done to generate additional family income. The enterprise is carried out part-time until the income generated is enough to meet all the needs of the household. Commercial poultry breeds (i.e. Ross, Cobb) are either purchased at 3 or 6 weeks of age from large commercial producers and grown until they meet the size demanded by customers (8–10 weeks old, 2.2–2.8 kg live weight) or marketed within a few days of purchase. It must be noted that the target market for these birds requires a tougher meat from a mature bird, similar to that obtained from free-ranging indigenous chickens.

Very few farming households rear day-old chicks to 6 weeks of age, probably because they do not have the required poultry-rearing knowledge and skills. Most losses of chicks during rearing, processing and marketing have been attributed to institutional, technical and economic constraints. Some of these constraints can be overcome through hands-on training, extension and technical follow-up within a favourable institutional environment. Apart from the difficulty encountered by resource-poor households to obtain start-up capital or credit, the necessary training in poultry rearing techniques, if available, costs far beyond what they can afford. Compounding these problems is the lack of access to inputs, due to high transport and transaction costs, and a lack of niche markets. Recommendations from our previous studies and workshops indicate that there is a great need for the training of trainers and training of households in poultry-rearing techniques (Swatson et al. 2001, 2003, 2004). It was also recognised that the benefits of training and technical assistance would have greater impact if the associated institutional and technical constraints to smallholder poultry production were removed. To identify basic requirements for the successful implementation of poultry training programs or projects, a series of participatory studies was conducted.

Purpose and objectives of study

A series of studies was conducted to determine the impact of promoting smallholder poultry development among peri-urban and rural farming households. The objectives were to identify educational strategies associated with the adoption of poultry-production techniques and how farming households determined what course of action to take to improve their productive process. The study would also shed some light on possible interventions to assist in improving small-scale poultry production among farming households.

Methodology

A sample of 300 individuals was randomly selected from households in peri-urban and rural areas. Equal numbers of males and females were selected. The ages of these individuals ranged from 16 to 67 years. Qualitative data obtained from focus group interviews were used in the design of other surveys that made use of multiple-choice and scale-type questions. Confidentiality of information was provided and maintained for individuals that were interviewed. Descriptive statistics were used to analyse survey data making use of Minitab Statistical Software (1998).

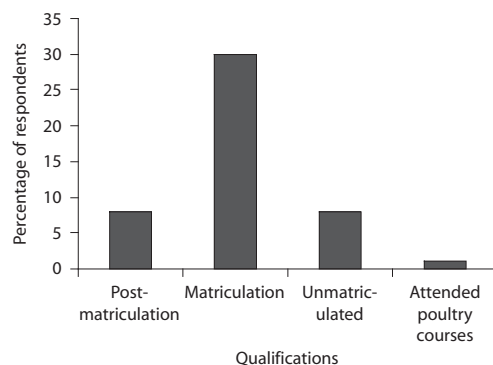


Figure 1. Qualifications and training of respondents

Results and discussion

Respondents had a limited knowledge of how to successfully and efficiently rear and market commercial broilers. Less than 2% of the respondents had attended poultry courses (Figure 1). There was a lack of interest in rearing day-old chicks to 6 weeks of age by farming households without the

required training, extension and financial support. This was partly due to the low level of information on issues such as brooding requirements for chicks, appropriate housing, disease control, technology and equipment, value adding and niche markets, financial management, micro-credit and record keeping. To develop a positive attitude towards poultry rearing as a commercial enterprise, respondents need to be aware of the importance and value of the basic principles of poultry production.

The study showed that, in evaluating the adoption of poultry-rearing techniques, individuals in farming households determine if it:

- is not risky or associated with losses (i.e. birds, incomes)
- improves the source of additional income of the household
- improves the protein food security and livelihoods of the household.

As the understanding of rearing practice increases, interest in its adoption also increases. Few emerging farmers were sceptical about spending money on disease control and supplementary feeding as a measure to reduce the risk in growing larger numbers of chickens. In general, local poultry-rearing knowledge was based on farming practices and past experience.

The most knowledgeable and trustworthy sources of poultry-rearing information were extension agents who had specialised knowledge in poultry production (Figure 2). Knowledgeable and trustworthy information sources significantly influenced the respondent's adoption decision. Even although farming households had a low and unreliable access to inputs, micro-credit, extension and veterinary services, these services were not relevant to their needs. For instance, 95% of the respondents kept Venda or Ovambo free-range birds but information available was on Ross broiler chickens that are not adapted to the harsh environment faced by village chickens.

The most accessible and convenient sources of poultry information were local poultry dealers (Figure 3) from whom farming households could obtain chicks, equipment and some veterinary medicines. Extension agents tended to live far from communities and farming households, and their visits to households were irregular.

Poultry information was communicated to households mainly through extension visits and during meetings held with households by extension agents, non-government organisation (NGO) staff,

community field workers and local poultry companies (Figure 4). Farmers also tended to lack the knowledge and skills needed to make correct use of inputs (e.g. Newcastle disease vaccines, automatic drinkers and gas brooders).

The adoption rates of poultry-rearing practices for indigenous free-ranging chickens were highest for supplementary feeding and housing. Most respondents protected their birds from adverse weather conditions and provided supplementary feeding—making use of kitchen waste, termites and leafy/unconventional protein sources. Acquiring information or skills from trustworthy, knowledgeable and convenient sources was based on the farming household's own experience, interactions with other experienced poultry farmers and extension agents. This played an important role in adoption of poultry-rearing innovations (Figure 5).

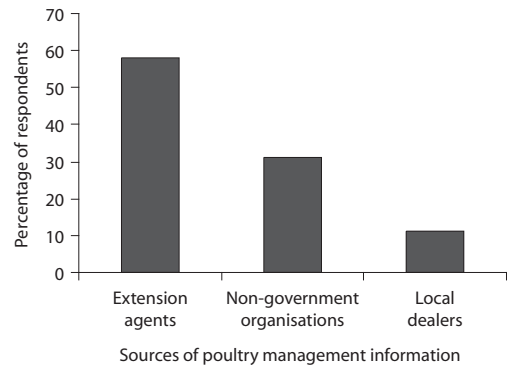


Figure 2. Sources of knowledgeable and trustworthy sources of poultry management information nominated by respondents

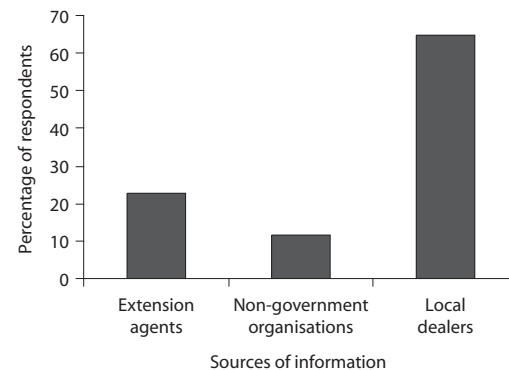


Figure 3. Sources of poultry information identified by respondents as being accessible and convenient

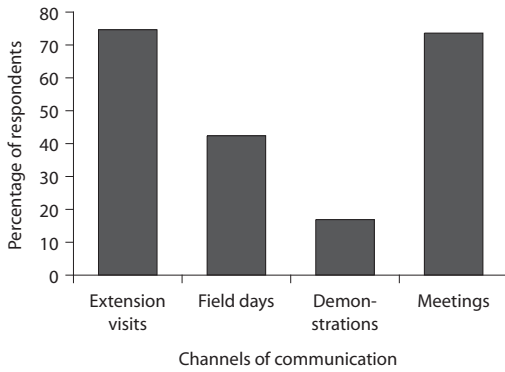


Figure 4. Channels of communication of poultry-rearing information to farming households

It is important to provide training to people working with communities so that they will be well equipped to provide trustworthy and practical poultry-rearing information to farming households. The empowerment will require hands-on practical training in all aspects of poultry production under various systems of management at reputable institutions such as Cedara College of Agriculture. The empowerment will promote competence of these trainers. Communication networks and farming cooperatives had a large influence on adoption decisions. It is suggested that the South African Network for Smallholder Poultry Development, in collaboration with relevant stakeholders, should establish an overall strategy on the sustainable use of poultry in poverty reduction and income generation amongst peri-urban and rural households. As not many institutions and NGOs engaged in poultry

development projects have the required experience and skills in poultry production, collaborating and combining forces will establish a partnership drawing on and complementing individual strengths. A farming household’s practical poultry knowledge is increased by interactions with other experienced poultry farmers and extension agents. This background calls for the development of practical approaches and methodologies to facilitate the involvement of rural households at all stages of poultry project initiation, development, implementation, and monitoring and evaluation. This will ensure that households are able to either do away with inappropriate technologies early in the evaluation process, or adopt promising poultry-production technologies.

Conclusions

For small- to medium-scale poultry enterprises to be socioeconomically viable among peri-urban and rural households, issues such as the training of interested households, trainers and field staff in poultry-rearing skills need to be addressed. The provision of relevant socioeconomic and technical information to households is necessary, because most individuals are dependent on economic criteria for making an adoption decision. Furthermore, households are able to sufficiently grasp the basic principles and concepts of poultry rearing if they have been involved at an early stage of planning and implementation of appropriate poultry-rearing technologies. Inappropriate use of technology results in poor credibility and reliability ratings for an innovation

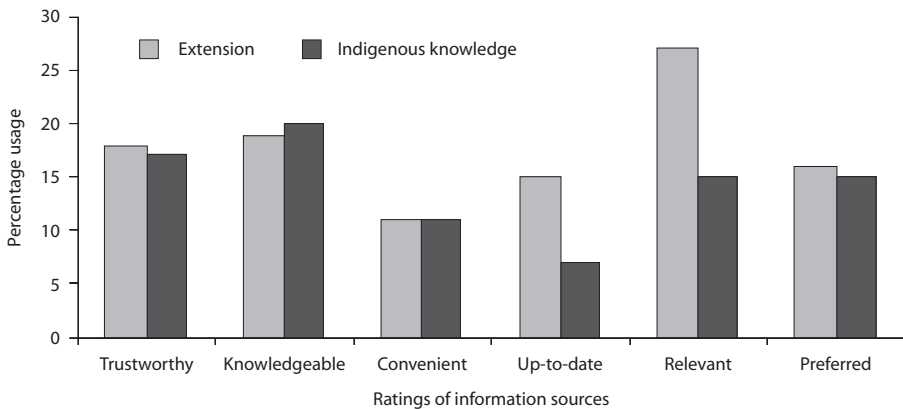


Figure 5. Respondents’ usage ratings of poultry information sources at their disposal

and its adoption. Legitimate claims of resource-poor farming households to institutional support and resources should receive greater recognition through initiatives of the KwaZulu Natal Department of Agriculture and Environmental Affairs such as the *Siyavuna* and the agricultural outreach project of Cedara College of Agriculture.

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The role of village chickens in HIV/AIDS mitigation in Manica and Sofala provinces of Mozambique

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Abstract

In households where there is a lack of able-bodied workers, such as those affected by HIV/AIDS, village poultry provide a source of income and high-quality nutrition without requiring much in the way of labour or financial inputs. Restocking with village chickens can be of utmost importance for poverty alleviation, as the poorest households and families affected by long-term disease such as HIV/AIDS find chicken raising an easy activity that can contribute to household food security and income. Given that women are the main carers of sick people, and that chickens are usually under women's control, chickens can play an important role providing them with additional resources to carry out their important task of supporting people living with HIV/AIDS.

This paper presents a case study on the improvement of village chicken production by junior farmers and people living with HIV/AIDS in Mozambique. The case study demonstrates methodologies that contribute to the wellbeing of both households and communities through improved food security and HIV/AIDS mitigation.

Introduction

Village chickens can be found in all developing countries and play a vital role in many poor rural households (Spradbrow 1993/94; Alders 2004; Alexander et al. 2004; Copland and Alders 2005).

They require the lowest capital investment of any livestock species and they have a short production cycle. Village chickens play an important role in households where there is a lack of able-bodied workers, such as those affected by HIV/AIDS or those that have a disabled family member. In house-

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holds headed by widows, children or grandparents, chicken represent the easiest species to raise for sale and home consumption, providing a source of high-quality protein and micronutrients, which play an important role in the nutrition of HIV/AIDS patients. Eggs can be stored for several days under village conditions and require very little energy or time to cook.

Mozambique is among the 10 countries in the world most affected by HIV/AIDS. The national adult HIV prevalence rate is 13.6% (MISAU-PCN/DTS/HIV-SIDA 2003) but the highest prevalence rates (19.8%, 21.1% and 18.7%, respectively) are found in Tete, Manica and Sofala, three provinces in the centre of the country (INE/MISAU/MPF/CEP-UEM/CNCS/UEM/MINED 2002).

This paper presents a case study on the improvement of village chicken production by junior farmers and people living with HIV/AIDS in Mozambique. The case study demonstrates methodologies that contribute to the wellbeing of both households and communities through improved food security and HIV/AIDS mitigation.

Project description

The Food and Agriculture Organization of the United Nations (FAO) is supporting new pilot activities that can mitigate the effects of HIV/AIDS on food security and nutrition in Mozambique's Manica and Tete provinces. Within the framework of this project, FAO is currently supporting the International Rural Poultry Centre (IRPC) to pilot improved management of village chickens and the vaccination of the flocks of people living with HIV/AIDS in the framework of home-based care systems run by two local non-government organisations (NGOs), the Mozambican Association to Support Widows and Vulnerable Children (ASVIMO) and Kubatsirana.

One of the major constraints to the production of village chickens in Mozambique is Newcastle disease (ND). Community-based ND control programs improve the livelihoods of poor livestock keepers in Mozambique through the effective and sustainable control of this devastating disease. Other constraints include shortage of feed protein, especially for chicks and laying hens and, as a result of poor housing and husbandry practices, high chick mortality due to cold, heavy rains, and predators. Once ND control has been achieved in the project area, secondary constraints mentioned above are

tackled by focusing on training in, and farmer experimentation with, low-cost improvements to village poultry husbandry. Once ND is controlled, producers will no longer need to hatch all their eggs to produce replacement stock and so the consumption of eggs becomes feasible. To ensure that the activities above are sustainable in the long term, the project also works with local health posts and primary schools to promote village poultry production and the consumption of poultry meat and eggs. Activities to improve farmer knowledge about avian and human nutrition are also used to discuss the components of a balanced diet for the farmers' families.

The IRPC secured funding from charity groups in Australia to support the distribution of one rooster and three hens and ND vaccination vouchers to child-headed households and families affected by HIV/AIDS in the project area. Following vaccination, the vaccinators present the vouchers to either ASVIMO or Kubatsirana to receive a payment for their services linked to the number of birds vaccinated.

Project achievements and challenges

The pilot project received a positive review, as it demonstrated the potential to deliver triple benefits: direct support to the people affected or infected by HIV/AIDS; income generation for the carers and the community-based organisations; and an increase in the carrying capacity of the communities in terms of supporting welfare activities (Sylvester 2005). The project has been expanded to more districts in five provinces and is ongoing. One major difficulty has been ensuring the supply and distribution of in-date ND vaccine. This is done via the Provincial Livestock Services to community vaccinators. It is needed to enable vaccination to occur at regular intervals so that flock immunity is maintained (IRPC 2005).

Discussion and conclusions

Improving the management of village chickens by families affected by, and people living with, HIV/AIDS contributes to HIV/AIDS mitigation, principally through improved household food security and income generation (IRPC 2005). Village poultry production also provides women and children with experience in small-scale business management and improved knowledge about human nutrition.

Families affected by HIV/AIDS are more likely to make use of the above benefits when veterinary

services work in collaboration with the ministries of Education and Health to improve general knowledge about human nutrition and disease prevention and control (IRPC 2005).

Acknowledgments

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Characterisation of indigenous chickens under traditional farming systems in Limpopo province, South Africa

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Abstract

In order to contribute to the sustainability of livelihoods through the introduction of appropriate indigenous poultry production and marketing technologies, it is necessary to characterise chickens under traditional management conditions. This is part of a South Africa Netherlands Research Programme on Alternatives in Development activity. Accurate and reliable baseline data obtained will enable modelling of the impact of interventions and selection of indigenous poultry breeds to be used in development projects.

The indigenous chickens owned are scratch chickens and quite adapted to scavenging behaviour. The purebred Naked-Neck birds have a completely naked neck, whereas the crossbred type has a tassel of feathers on the front of the neck. The Venda breed is a multi-coloured bird with white, black and red speckle patterns. The comb is rosy in colour. They have a brooding instinct and are the dominant breed in Limpopo province. The Ovambo has a small to medium body conformation and a variety of colour patterns. The Ovambo is comparatively active in seeking food and may prey on small rodents. Fifty-seven per cent of the scavenging chickens roosted in trees during the night to avoid predators and survive the harsh environmental conditions.

Very high body weights are obtained for cocks and hens during the winter (1.89 kg ± 0.08 kg, 1.48 kg ± 0.07 kg), respectively, and spring (1.81 kg ± 0.03 kg, 1.47 kg ± 0.04 kg), respectively.

The number of cocks kept per household tends to be at its peak during summer (November–January). This number shows a downward trend in autumn (February–April) and winter (May–July), and rises again in spring (August–October). This autumn–winter fall in numbers may be linked to the seasonal utilisation of chicken for rituals and food. Summer is a planting season for most crops grown by households and a manageable number of chickens is kept in a semi-intensive manner in chicken coops or shelters. The eggs laid per clutch is within the range 7–13, with a length of lay per clutch of 13–18 days and a hatchability of 65.7%. The average egg weights (g), shell thicknesses (mm) and shell membrane thicknesses (mm) for the Ovambo, Venda, Naked Neck and Koekoek breeds were, respectively: 53, 51, 56 and 54; 0.35, 0.37, 0.40 and 0.35; and 0.018, 0.020, 0.034 and 0.026. The egg shell weights (g), albumen weights (g) and yolk weights (g) for the Ovambo, Venda, Naked Neck and Koekoek were, respectively: 6.35, 6.89, 6.94 and 6.46; 28.74, 27.93, 31.44 and 30.18; 17.86, 16.73, 18.02 and 18.62. The average ages of birds at first egg laying were 135 days for Ovambo chickens and 126 days for Venda chickens, a longer time to laying than that for the Leghorn (118 days). The average number of eggs produced per hen during its productive cycle was 126 for Ovambo chickens and 154 for Venda.

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Promoting community development through improved village chicken production in Chibuto district, Mozambique

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Robyn G. Alders² and Mohamed Harun²**

Abstract

Corridor Sands Limited (CSL), a Mozambican mining company and member of the BHP Billiton Group, has been granted a concession by the Mozambican government to establish a large mineral sands mine near Chibuto in southern Mozambique.

The heavy minerals are found in areas occupied by rural families that need to be relocated. This must be done with a great deal of sensitivity to their culture, social structures, health and livelihoods.

CSL has included improved village chicken production as one of its community development activities. The aim is to facilitate and improve village chicken production to help increase rural incomes and improve nutrition among rural families. To achieve this aim, CSL is working in collaboration with the Gaza Provincial Livestock Services and the International Rural Poultry Centre to promote:

- the control of Newcastle disease using I-2 ND vaccine
- increased awareness among school children and nursing mothers about improved nutrition
- improved poultry husbandry using low-cost practices.

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An analysis and assessment of perceptions of free-ranging indigenous chicken production among some households in KwaZulu Natal, South Africa

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Abstract

Food security and socioeconomic, religious and cultural considerations are some of the reasons why households keep indigenous chickens. Freely scavenging indigenous chickens contribute 16.5% of the total meat consumed by households and a negligible cash income is obtained from the sale of chickens. In order to identify basic requirements for the successful implementation of free-ranging poultry projects, a series of participatory studies was conducted to obtain reliable data on poultry production in KwaZulu Natal, South Africa. The objective of the current study was to review, analyse and assess public perceptions about the use of free-ranging poultry meat, and shed some light on the possibilities for interventions to assist in improving indigenous poultry production. The study also sought to identify and formulate strategies to exploit market opportunities among urban, peri-urban and rural dwellers. The sample for this survey consisted of some 300 randomly selected individuals from households. There were equal numbers of males and females, and respondents' ages ranged from 16 to 67 years. Eighty-seven percent of those who had eaten free-ranging chicken meat previously would eat it again. However, 13% of the respondents did not like the meat because it was too tough. Ninety-five percent of the birds are purchased/obtained as live birds and there is a lack of well-established distribution outlets such as supermarkets and butcheries where the processed meat could be purchased. There were a few hygiene concerns, as many birds were not slaughtered in certified abattoirs or passed as wholesome by a meat inspector. Also, some birds were not treated as humanely as are other livestock. There was a lack of awareness and interest in making use of indigenous chickens amongst 23% of city dwellers due to the low levels of information and awareness about the meat. Two pilot projects on free-ranging poultry have been set up at Richards Bay Minerals community development project and Weenen to promote indigenous free-ranging chicken production and consumption, and the interest has been astonishing. Breeds kept at these sites include the Venda, Ovambo, Koekoek and Naked Neck. It is possible that targeted educational and marketing strategies that keep in mind the multicultural backgrounds of communities could help to develop the indigenous poultry market.

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Synchronised hatching as a strategy for improving productivity of village chickens in Uganda: a case study in Rakai district

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Abstract

Rakai district is one of the rural districts of Uganda that has been hit hard by the HIV/AIDS epidemic. As a result, there is a big challenge presented by orphans who are either fending for themselves or are provided for by relatives. A village chicken project was initiated and implemented in Rakai district by Community Integrated Development Initiatives (CIDI), a non-government organisation, in collaboration with several stakeholders, between 2003 and 2005. The overall objective was to contribute to poverty alleviation among subsistence farmers. The project targeted 400 resource-poor households as the initial beneficiaries. These included four households headed by orphans, two orphanages, 50 female-headed households (most of them widows), 250 housewives and 94 men. The beneficiaries were organised in groups and trained in modern poultry-management practices such as disease control, and in how to synchronise hatching of chicks, using broody hens. Synchronised hatching ensures that clutches of chicks are of the same age. This simplifies management, especially in the provision of feed and in vaccination. The groups were provided with local village hens and Bovan cockerels for cross-breeding. This cross produced F₁ offspring, which in turn were crossed with commercial broiler cocks, to produce F₂ offspring. By the end of the 2 years, the project had made significant impacts. The major achievements included an increase in flock turnover, an increase in egg and chicken sales, increased crop yields as a result of using chicken manure, improved household nutrition, marked improvements in housing and living conditions, and an ability to pay dues for children going to school, as a result of increased household incomes. The main challenges faced by the project included a high requirement for concentrated feed for the birds as a result of adopting the synchronised hatching technology and the deep litter system, and outbreaks of diseases such as fowl pox and fowl typhoid. Newcastle disease was under control because of the tight vaccination schedule.

Background

Rakai district is located in south-western Uganda and people in this district have been devastated by

the HIV/AIDS epidemic. The disease was first diagnosed here in 1983 and since then it has caused serious socioeconomic problems. The orphans left behind usually suffer most, although many of their relatives are engaged in taking care of them. Some of the orphans take care of themselves in child-headed households, while others become street children in urban areas because their parents sold off family property to get medical care during their sickness (Hunter et al. 1993). One way of assisting such households is to help them and the community at large to utilise the locally available resources, such as village chickens, to generate income.

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Village chickens are found in almost all households in Rakai district (UBOS 2002). Haslwimmer (1994) suggested that village chickens are a resource that could be developed to increase household incomes. A village chicken project was therefore initiated and implemented in Rakai district by Community Integrated Development Initiatives (CIDI), a non-government organisation, in collaboration with several stakeholders, between 2003 and 2005. The overall objective was to contribute to alleviate poverty among subsistence farmers, especially women.

Methodology

The project targeted 400 resource-poor households as the initial beneficiaries. These included four households headed by orphans, two orphanages, 50 female-headed households (most of them widows), 250 housewives and 94 men. The main beneficiaries were women (60%), in recognition of the significant role they play in food-production enterprises. CIDI's approach for technology dissemination was group-based. The technologies are disseminated to farmers through groups because of their multiplier effect. The beneficiaries were organised into 20 groups, with an average of 20 members per group, as the initial beneficiaries of the project. Each member

represented a household. The project thus directly reached 400 households in the two sub-counties of Ddwaniro and Lwanda. Workshops were conducted to build the capacity of groups to manage the chicken project. The farmers were trained in poultry management practices such as disease control, feeding and the deep litter system of rearing chickens. They were also trained in how to synchronise hatching of chicks, using broody hens, since the cost of artificial incubation is prohibitive. Uncontrolled natural incubation results in clutches of various ages, with consequent complications in management.

Under a synchronised hatching system, eggs are collected from nests each day and stored in egg trays until required for incubation. When hens start becoming broody, each broody hen is allowed to sit on an egg until others also become broody. After accumulating a sufficient number of broody hens, the eggs that hens have been sitting on are removed and each hen is given 12–15 eggs, depending on the number and the age of the collected eggs. Eggs that are more than 10 days old are not suitable for setting. Thus, eggs are set at the same time, ensuring synchronised hatching. This gives rise to many chicks that are of the same age (Figure 1), which makes the implementation of management and vaccination programs easier.



Figure 1. Thirty five chicks hatched on the same day, by three hens
Photo: Dr Connie Kyarisiima

Each group was provided with 20 well-selected local village hens and two Bovan cockerels for cross-breeding. This cross produced F₁ offspring, which in turn were crossed with commercial broiler cocks to produce F₂ offspring. The initial beneficiaries passed on chickens to other needy farmers. In line with the government's policy of not providing handouts to farmers, the project costs were shared between CIDI and the communities. CIDI met 80% of the project costs while farmers contributed 20%. This developed a sense of ownership in the beneficiaries. CIDI field staff made regular field visits to provide, as well as training, services such as vaccination, and advice and guidance on record keeping. All chickens in the project area were vaccinated against Newcastle disease, using a live vaccine (La Sota strain $\geq 10^{6.5}$ EID₅₀). Group leaders were further trained in poultry management and were charged with the responsibility of overseeing the project chickens in their local communities. They served as community-based trainers (CBTs), reaching out to farmers who were not attached to the project. An evaluation was conducted at the end of the 2-year project period.

Achievements

By the end of the 2 years, the project had made significant impacts. Records showed that the initial beneficiaries had hatched between 1,000 chicks (e.g. Kyosimba Onaanya group) and 2,000 chicks (Gakuweebwa Munno group). All the 400 households that were targeted by the project as direct beneficiaries had already been covered. Farmers had also recorded very good hatchability rates (68–87%) with synchronised hatching. Some farmers, mostly CBTs, had already hatched chicks for more than five cycles and performed comparatively better than the average for their areas. Vincent Ssemujju, a CBT of Luteebe village (Tukolerere Wamu group), for example, had so far hatched 2,000 chicks. He had an estimated annual income of 1.8 million Ugandan shillings (equivalent to about US\$1,200) from chicken and egg sales. As a CBT, Ssemujju had transferred the technology of synchronised hatching to 12 other farmers in his village.

Owing to the widespread adoption of synchronised hatching and improved poultry husbandry practices, both egg and chicken sales had significantly increased in the project area. Some households reported annual sales of approximately 200 trays of fertile eggs at a

price that is twice as much as commercial table eggs, 200 chicks at 1–2 months of age and 30 adult birds in a year. The cost of an adult improved chicken was more than twice that of a commercial broiler chicken, because the former was said to taste better than the latter. During one of the visits, George William Jjumba of Tulembeke Orphans' Care Group boasted that a person growing beans could not compare with him because such a farmer could not sell anything during such dry months. He reported that the whole cycle had reached over 2,000 birds since joining the project in October 2003. Generally, chicken production in the area was high. The district veterinary officer remarked that records at the livestock checkpoints showed increased chicken trafficking across the borders of Rakai district into neighbouring districts. He attributed this increased chicken production to the CIDI chicken project. Farmers appreciated the practice of record keeping because it enabled them to track their income and expenditure, as well as the turnover of their chicken flocks. Many of the farmers who were still having difficulty in using the formatted record sheets had resorted to the use of exercise books. Most of the farmers had not completed even primary-school education.

Orphan-headed households that participated in the project had benefited from their poultry enterprises. For example, Isaac Sserwanga of Ddwaniro subcounty, whose parents died in 1998 leaving him and his three siblings in a makeshift grass thatched house, had so far constructed a three-bedroom, brick-and-mud, iron-roofed house. He was able to pay school dues for his three siblings who were still in primary school. The manure generated in the chicken houses had increased his pineapple and banana yields to the extent that he could now sell bunches of bananas instead of loose banana fingers.

Household nutrition had also improved remarkably, not only for the participating households but also in the whole community. The participating farmers reported that their family members ate an egg at least three times a week, and some families had a menu consisting of a chicken every Sunday. Marked improvements were noted in housing conditions, family incomes, payment of school fees and purchase of scholastic materials for children.

One of the outputs of the project was the formation of a Chicken Breeders' Association (The Rakai Local Chicken Breeders' Association (RALOCBA)) that would help in marketing of birds as well as ensuring supplies of feed. The association

now operates a feed-supply centre in Lwanda township. The centre sells feeds and drugs to the farmers, besides offering free technical advice to them. The centre also serves as a marketing outlet for farmers for a small service fee. The association is expected to supervise the chicken breeding program in the whole district.

Challenges to the project

The following are the main challenges and problems faced by the project:

- The cost of feeds for the birds was a big problem to the farmers because of the increased flock turnover resulting from the adoption of the synchronised hatching technology.
- There was a serious problem of scarcity of water in the project area, especially during dry seasons. Much of the available water sources have very poor-quality water that is not suitable for either humans or livestock.
- Some farmers, especially those afflicted with HIV/AIDS, had poor health. Two of the households benefiting from the CIDI chicken project had lost members due to HIV/AIDS. One of the members lost his wife and he, too, was bedridden for several months and his chicken project collapsed.
- There were outbreaks of diseases such as fowl pox and fowl typhoid.

Key lessons

The key lessons learnt from the project were that:

- the group approach is cost effective since most of the training is done at group level—even synchronised hatching can be organised at group level
- synchronised hatching of chicks increases flock turnover in village chickens
- synchronised hatching makes administration of vaccination programs in rural areas easier
- vaccination campaigns should cover other common diseases such as fowl pox, fowl typhoid and infectious bronchitis.

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The efficacy of a thermostable Newcastle disease vaccine in village chickens when administered by community volunteers: a South African experience

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Abstract

Initial work done on the vaccination of village chickens in the communal areas of South Africa demonstrated that the Nobilis Inkukhu® commercial thermostable vaccine was able to protect chickens against virulent Newcastle disease challenge when applied by eye-drop, in water or in feed (cooked maize meal). In the initial trial work, all vaccines were prepared by university staff or graduate students, rather than poultry owners themselves. In order for vaccination of the village chickens to be carried out on a more extensive scale, it is obviously necessary for a larger body of people to be enabled to vaccinate chickens. It was also felt by the researchers that once community members had to make an effort to get their chickens vaccinated, it would be possible to determine somewhat more accurately what was the real level of enthusiasm for vaccination of chickens among the community.

The trial work was carried out in the village of Disaneng which lies in the Northwest province of South Africa. Visual and practical training material was prepared and presented to community-elected and volunteer 'vaccinators'. Vaccinators were then required to register all the poultry owners in their ward who wished to have their chickens vaccinated. Once an indication of the number of chickens to be vaccinated had been made available, Inkukhu vaccine was supplied to vaccinators free of charge. Vaccinators were responsible for the organisation of the vaccination campaign, including the storage and preparation of the vaccine for application. Vaccine application methods differed between wards.

All nine wards in the village were initially involved in the vaccination campaign, with a total of 482 households owning 6,141 chickens participating. Detailed survey work carried out in three of the participating wards indicated that this represented slightly more than 60% of the chickens in the area. Involvement in a second round of vaccinations, 1 month later, was far poorer, with only 211 households owning a total of 1,636 chickens participating.

Approximately 1 month after each vaccination campaign, blood samples were collected from a random sample of about 150 chickens that had been vaccinated and tested for circulating antibodies to Newcastle disease, using the haemagglutination inhibition test. These results showed variable levels of protection achieved, but were influenced more by the area (vaccinator) from which they came, than the vaccine application method used.

Work is planned for July 2005 to investigate the reason for the sudden drop-off in community participation between vaccination campaigns as well as to obtain further information about vaccine handling and preparation by the community vaccinators.

Another unexpected finding was the rate at which chicken flock numbers appeared to alter between vaccination campaigns. The reason for this has yet to be established, but the fluctuations may indicate that chickens are moved between homesteads belonging to a single family, depending on what forage is available. Another possible explanation is unidentified disease problems.

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Contribution to set up a strategy to develop guineafowl farming in Sahelian Africa as part of the fight against poverty

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Abstract

This note aims at giving the first results of the implementation of the strategy for the promotion of guineafowl farming in Sahelian Africa started as part of the Special Programme for Food Security launched in 1996 by the Director-General of the Food and Agriculture Organization of the United Nations (FAO) for low-income countries suffering from chronic food deficit.

The strategy used is based on a technically, economically and ecologically viable micro-project approach. These projects produce a minimum income of about US\$30.00 per month for a US\$400–500 investment. Above all, this approach is about promoting local know-how by helping the Sahelian populations to make the most of the assets they have, particularly a long tradition of raising guineafowl and an exceptional adaptation of the birds' biology to the ecological context of the countries involved, in this case Chad, Niger, Mali and Burkina Faso.

The first results, evaluated on the basis of three criteria—sustainability of the activity, increase in income and an actual increase in the growth rate of the bird population—confirm the viability of this strategy and show a real trend of the beneficiaries to self-finance all expenses necessary to improve the productivity of their bird farming.

Constraints, however, persist: there is a particular weakness relating to the growth rate of the bird population, the root causes of which lie in inadequate technical training of beneficiaries in raising young guineafowl, inadequate practical technical skills of extensionists, and the wrong choice of beneficiaries by the village community. It is important to correct these deficiencies and to promote guineafowl-raising development goals in order to create jobs and establish guineafowl raising as an important lever for the development of Sahelian countries.

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Enhancing food security in villages by improvement of local chickens

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Abstract

A 3-year program to improve Mkuranga food security through sustainable agriculture was financed and implemented by Vrebaseilanden Country Office, Tanzania, in collaboration with the Tanzania Association of Women Leaders in Agriculture and Environment. Improvement of local chicken production was one of the project components. Farmers were selected to implement the program from three villages: Sotele, Mwanambaya and Mwanadilatu.

The project has enhanced food security through increased productivity of village chickens and has raised incomes and nutrition levels of farm families.

The program to improve local chicken production involved:

- on-farm training of farmers on chicken management,
- distribution of purebred cockerels for upgrading the local chicken flocks
- disease control
- monitoring and evaluation.

Two hundred and ninety-six farmers were trained on poultry management (housing, nutrition, disease control and marketing).

Two hundred dual-purpose purebred Rhode Island Red poultry were distributed to farmers in the three collaborating villages, on the agreement that each farmer receiving a purebred cockerel would contribute to other farmers two of the offspring it sired.

Newcastle disease (ND) is the greatest impediment to the production of the village chickens, and has been reported to cause over 90% mortality. In choosing a vaccine for use in the village situation, previous findings about the ability of farmers to apply ND vaccine were considered by facilitators. Between January and June 2005, 2,058 chickens were routinely vaccinated against ND at Mwanambaya, 2,081 at Mwanadilatu and 1,600 at Sotele villages.

Promising growth performance and quick adaptability to local conditions of the introduced cockerels and hatched chicks were observed. However, poultry thefts discouraged farmers from expanding their poultry units. Nevertheless, it is expected local chicken egg production and size will improve and contribute to alleviation of poverty among village families as planned in Tanzania's National Strategies for Growth and Poverty Reduction.

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Collaborative approaches in Newcastle disease control in Malawi

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Abstract

Collaborative arrangements were initiated by the Department of Animal Health and Livestock Development of Malawi with four non-government organisations (NGO) to enhance the implementation of poultry-related activities and control of Newcastle disease (ND) in village chickens. Collaboration was established in two different ways: through negotiation with the Southern Africa Newcastle Disease Control Project and voluntarily. The voluntary collaborative arrangement proved successful, with collaborating NGOs contributing resources towards the implementation of ND control activities. In contrast, negotiated collaboration did not result in the NGOs fully committing themselves to the implementation of a ND control program.

A memorandum of understanding to bring stakeholders together to systematically solve existing and emerging problems in the fight against ND in village chickens in rural areas was drafted. It was ratified jointly with NGOs and other stakeholders to ensure that there was common understanding of the coordination mechanism. The NGOs that voluntarily opened collaboration with the Department of Animal Health and Livestock Development directorate showed more willingness to formalise the collaborative arrangement than did NGOs that were brought on board through negotiation. The former group trained more community vaccinators and vaccinated more chickens during the campaigns than did the latter.

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The key role of Newcastle disease control in the activities of women's groups in Chalinze village, Tanzania

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Abstract

Poultry raising is an important activity for the people of Chalinze village, particularly for the women, who are the main poultry owners. Of the 1,142 households in the village, around 85% keep poultry, mainly chickens, which find a ready market at the nearby trading centre located on the main highway from Dar es Salaam. Money derived from the sale of chickens is used for such things as paying school fees and for medical services, and even for house construction. Chickens are also used as food, gifts for visitors and in traditional healing.

Poultry keeping in the area faces a number of constraints. One of the most important of these is Newcastle disease (ND). When, in 1999, the women realised the importance of ND, they formed groups and tackled the problem with the assistance of the local extension officer. La Sota vaccine was initially used to control ND, but I-2 ND vaccine was introduced in 2004, since it offers the advantage of thermotolerance. In vaccinated flocks, the mortality due to ND has fallen from around 85% to only 5%.

There are four women's groups in Chalinze village, with a total membership of 95. The women raise chickens, guinea fowl and ducks, and keep detailed records of production, vaccination, marketing and prices, training, and research activities in pilot units. Sales of guinea fowl and chickens provide an important contribution to family income. This paper describes the composition, role and activities of the women's groups in Chalinze and the key role that poultry raising and ND control have played.

Introduction

Chalinze village is located in the central zone of Tanzania, around 60 km from Dodoma, the political capital. It is one of 128 villages administered by Dodoma Rural District Council. There are around

1,142 households in the village, which has a total population of 4,155. Agriculture is the mainstay of the community. Vegetables, maize, sorghum, pearl millet and sesame are cultivated for food, and sunflower and groundnuts as cash crops. Livestock raising is also an important activity. Other income-generating activities are salt making and handicrafts.

Women are the main poultry keepers in Chalinze. Around 85% of households keep chickens, which are used as food, in traditional healing and as gifts for visitors. Funds from the sale of chickens supplement household income and are used to pay for house construction, school fees and medical services. Poultry keeping in the area faces a number

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of constraints, one of the most important being Newcastle disease (ND). In 1999, when the women realised the importance of ND, they formed groups and tackled the problem with the assistance of the local extension officer. La Sota vaccine was initially used to control ND, but I-2 ND vaccine was introduced in 2004, since it offers the advantage of thermotolerance. Since vaccination was introduced, the mortality due to ND in vaccinated flocks has fallen from around 85% to only 5%.

Group composition and organisation

As the main poultry owners, women in Chalinze were quick to recognise the impact that ND was having on their flocks. Since their flocks were small, they found it difficult and expensive to purchase vaccine individually. In 1999, they decided to form groups to tackle the problem jointly, under the supervision of the local extension officer.

There are four women's groups in Chalinze village with a total of 95 members. The groups, together with groups in the adjacent villages of Wilunze and Manchali, are clustered into the DIRA association. The DIRA is led by a coordinator whose role is to harmonise all the activities of the groups and to collect information from them. Each group has, in addition to a coordinator, a facilitator, assistant facilitator, chairperson, secretary and group mobiliser.

The main activity of the groups is poultry raising. Other activities are salt making, gardening, sorghum seed production, handicrafts, housekeeping and child-care. The women have also formed a drama group.

Poultry raising

Chickens, guineafowl and ducks are the main poultry species kept in the area. The chickens are free range. They scavenge during the day but are locked in the owner's house at night. A few members have small houses for their chickens and other birds. Supplementary feed—for example, maize, bran, millet and sorghum—is offered when it is available and clean drinking water is provided. The 'average' flock consists of 20–30 chickens and 30–80 guineafowl. Since the guineafowl fetch higher prices at the market than chickens, the chickens are used to hatch guineafowl eggs and rear the chicks. Ducks are not common, since they fetch low prices at the market. A trial is being conducted

using ducks to hatch guineafowl eggs, thereby allowing hatching twice in one laying period. Groups keep records of the average prices of chickens and guineafowl, and of details of vaccinations, training and trials in pilot units.

Chicken owners have a ready and reliable market for their birds, and prices are good. The chicken trading centre located along the main road is recognised as a major source of poultry by chicken traders. Traders sometimes go house to house to buy chickens or buy chickens at the trading centre. Birds are then on-sold to people travelling to Dar es Salaam and Morogoro, or are sent to Dar es Salaam.

Newcastle disease control

Chicken mortality due to ND is a problem in the area. When the women realised the impact that ND was having on their flocks they sought assistance from their extension officer, asking him to find a solution. The district office advised vaccination. Initially, La Sota vaccine was used to control ND, but I-2 ND vaccine was introduced in 2004, since it offers the advantage of thermotolerance. Farmers vaccinate three times a year, in April, August and December, to ensure that flocks are protected from ND all year round. The group coordinators and leaders are responsible for vaccination within the groups and work under the supervision of the chief coordinator of DIRA and the extension officer.

The vaccine is purchased from the district office with funds contributed by the members. In the village it is kept under a water pot until it is used. There is no refrigeration. Since I-2 ND vaccine was introduced in 2004, the groups have vaccinated five times (May 2004–August 2005). If other people in the area wish to have their chickens vaccinated, the cost is TSh30 (around US\$0.03) per chicken.

Training

Training is recognised as an essential element in the work of the women's groups. Three group coordinators have undertaken training in development and leadership, and a number of group members were also trained in crop and livestock husbandry. Training was by distance education in all these cases, and the women were self-funded.

Fifty-eight group members were trained in ND control by the district officer responsible for ND control, using materials prepared by the Southern

Africa Newcastle Disease Control Project (SANDCP) drawing on information in Alders et al. (2002). One member attended a 3-day training course on poultry husbandry and ND control sponsored by SANDCP in 2005. The extension officer also participated in a SANDCP 3-day training course in ND control for extension officers.

Achievements

ND regularly killed about 85% of the poultry population in the village before vaccination was introduced. Little benefit was realised from the women's poultry due to the regular devastation of the flocks. Although the disease is still a problem in unvaccinated flocks, mortality due to ND has fallen to around 5% in vaccinating households. These deaths are attributed to introduction, into vaccinated flocks, of unprotected chickens from non-vaccinating areas.

Proceeds from the sale of chickens and guinea-fowl make a significant contribution to household income. For example, one group member is paying the fees for her child to study at the local vocational training institute, while another is building a house using the proceeds from the sale of her chickens.

The women's groups were instrumental in helping to organise activities to mark World Rural Women's Day in October 2004. It was the first time that the day had been celebrated in the area. To honour the important contribution that women make to rural life and development, training was held in ND control, women's rights on land tenure, HIV/AIDS and malaria.

Plans for the future

Widows and orphans will be included in the groups' future program, so that the nutritional status and income of these most vulnerable members of the community will be improved. Vaccination campaigns will also be extended to all households (and chickens) in the village.

Following the successful celebrations held in 2004, the groups plan to celebrate World Rural Women's Day 2005 with further training in ND control, women's rights on land tenure, the effects of female genital mutilation, the effects of malaria and in reducing the numbers of deaths of children under 5 years of age.

Conclusion

The recognition of the benefits that can be derived from poultry, and the need for effective control of ND, were the stimulus for the formation of women's groups in Chalinze. Poultry raising has become an important income-generating activity in households of group members since effective control of ND through vaccination was introduced.

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Field-based poultry schools for poor, illiterate farmers in Kenya: lessons learnt from a pilot project

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Abstract

In 2002, the Danish International development Agency and the Government of Kenya launched an initiative to use smallholder poultry development as one tool for poverty alleviation. The initiative is linked to the Micro Enterprise Development Project (MEDP) and the Micro Finance Institution Initiative (MFII) under the overall Agricultural Support Project (ASP). To initiate the pilot project, a stakeholder workshop was prepared by the poultry network and the ASP. The workshop explored the possibilities of family poultry production projects in relation to the national strategies for poverty alleviation and food security. The aim was to effectively assist decision-makers in government, non-government organisations and donor organisations to optimise the impact of projects through technical training, social organisation and the use of credit schemes. A pilot project based on the workshop was subsequently initiated in 12 villages in Taita Taveta and Kwale districts in 2003.

The lessons learnt from the pilot project in ASP are that many village women, be they poor or better off, see local poultry as having good potential for income generation, as well as for enhancing social status and credibility in the local communities. A smallholder poultry farmer field school (FFS) from egg to egg scheduled to run for 7 months was almost complete in April 2005. The fertile eggs that started the cycle produced pullets ready to lay.

The original philosophy was to keep the technical inputs as simple and adaptable as possible. A field visit in April showed that all women involved have now accepted a few important technical tools that were first introduced during the model phases: the use of baskets to confine young chicks, feeding for confined young birds, and vaccinations. From the meetings and individual visits to FFS members, it is noted that the FFS has empowered women and their villages with knowledge and techniques to reduce chick mortality and improve the growth rates of local birds. The women have seen the gains of involvement in a learning program, and they have successfully raised and sold a few birds. Non-FFS members are interested, wishing they had joined the first farmer field school.

Investigations during initial formulation show no major constraints to the marketing of local poultry products. In general, farmers can sell their poultry products right at the doorstep. However, the development of smallholder poultry production takes time, and members in the FFS have only recently started to sell their products.

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According to the FFS members interviewed, chicken mortality during the first 3 months has generally decreased from 60–80% annually to 20%. In addition, the average weight of birds has increased, making it possible to sell birds weighing 1 kg as early as 4 months of age.

During the field visits, it was observed that different FFSs are approaching Microfinance Institutions (MFIs) differently. The most commonly used approach in Kwale is 'merry go round'. Some FFS are specifically doing merry go rounds to collectively buy starter feed for chicks. MFI credits were not found useful for the poor farmers to invest in poultry. FFS farmers in Kwale have gone through learning by discovery, whereby they identified marketing birds at a certain age as a coping strategy before shocks hit their production systems.

Findings strongly support the move from the original 'top-down' model approach to a more open-learning approach. The model approach was a scientifically sound approach, but had at least three major flaws: 1. it was expensive and time consuming to implement; 2. it did not question underlying assumptions, such as the use of micro-credit; and 3. it included the distribution of free inputs to farmers during the initial phases. The FFS approach seems to be less expensive and quicker and, more importantly, the testing and decisions on different solutions are made by the farmers in collaboration with extension staff, with no free inputs to the farmers, apart from subsidised training.

The lessons learnt so far are that a relatively slow, two-step training approach with a training of trainers or training of facilitators course for extension staff, and a farmer field school for the farmers, are necessary to change attitudes and improve the skills of extension staff (to become facilitators) and farmers.

Village chickens helping to keep the children off the streets in peri-urban Dar es Salaam: the Mama Mkubwa project

Adeodantha Lupindu¹, Nancy Macha², Mary Young³, Robyn G. Alders³ and Celia Grenning⁴

Abstract

The Mama Mkubwa ('respected elder aunts') ensure that orphaned, runaway or abandoned children in their communities are cared for within families. Local women volunteers, the Mama Mkubwa are advocates for the children in their local neighbourhoods, and ensure that they go to school, at least until primary schooling is completed, and are not abused. One constant concern of the Mama Mkubwa is how to feed the children: 'How can they study if they are hungry? They need food'.

The KYEEMA Foundation is helping these women to set up small chicken-raising enterprises so that they can earn a small income to buy food and other necessities for the children in their care. Ten Mama Mkubwa are being trained to rear local chickens and have been provided with small foundation flocks and other materials needed to ensure the health of the chickens. In addition, several of the women have been trained as community vaccinators and are planning their first vaccination campaign against Newcastle disease in their local community.

Introduction

The Tuamoyo Family Children's Centre is a community-based organisation that aims to be an outreach to runaway, orphaned or abandoned children. It assists children in meeting their basic needs, helps them to develop skills needed to reintegrate into the community and offers them friendship, enabling them to cultivate self-respect and to feel valued as people. The centre works with local

councils, schools, medical facilities and volunteers to ensure the welfare of the children.

The Mama Mkubwa ('respected elder aunts') program was set up to look after orphaned and street children in the homes of women volunteers. They are advocates for the children in their local neighbourhoods, making sure they go to school at least until primary level education is completed, and are not abused. The Mama Mkubwa are trained in how to talk with the children and how to begin income-generating projects that can assist in raising much-needed money to provide food for the children.

One such project is supported by the GRM International Development Fund. The fund is administered by the KYEEMA Foundation and is helping the Mama Mkubwa to set up small chicken-raising enterprises so that they can earn a small income to buy food and other necessities for the children in their care.

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Community description

The Tuamoyo Family Children's Centre is located in Kigamboni, in the Temeke district of Dar es Salaam. The area is best described as peri-urban, being only a short ferry ride from the centre of the city. Due to poverty, illness and family breakdown, there are many runaway, orphaned or abandoned children in the area.

Many households in the area keep livestock, mostly poultry (chickens, ducks and guinea fowl), but sometimes cattle. Chickens have multiple roles in the community. They are used as medicine, as dowry in some areas, in payment of fines in local disputes and as 'fast food' in emergencies. Since they are easier to sell than any other livestock species, chickens are a particularly important source of income for women, and are a good source of food, especially their eggs, which are very rich in protein.

Training activities

To facilitate easy communication with the Mama Mkubwa and encourage learning, the trainer selected was a female livestock officer with good interpersonal and language skills. The trainer had participated in a training of trainers course designed and conducted by the Southern Africa Newcastle Disease Control Project (SANDCP) for those involved in the training of community vaccinators.

A training program was developed, based on models developed by SANDCP and the International Rural Poultry Centre. It includes modules on

- Newcastle disease (ND) and its control
- nutrition and feeding of chickens (and of people)
- chicken housing and shelter
- chicken reproduction
- marketing
- conducting vaccination campaigns
- evaluating campaigns.

The schedule and timetable of activities were discussed with the Mama Mkubwa to ensure that training was conducted at times best suited to their home and project activities. The venue selected for the training was the headquarters for the Tuamoyo Outreach Program in Kigamboni. This ensured that all women could participate easily and that chickens were available for practical sessions throughout the course. Although many other community members expressed interest in joining the training course, the group size was limited to 12, comprising the 10

Mama Mkubwa and 2 other women directly involved in the project.

The module on ND and its control was based on the training course for community vaccinators designed by SANDCP. It extended over 3 days. SANDCP training materials and methods (SANDCP 2004) were used. The module consisted of discussion and practical sessions, and ample time was made available for the women to practise the skills involved in handling chickens and administering vaccine as often as possible. They were also encouraged to make short presentations to the group on topics covered on the previous day.

On the first day of training, the women participated in exercises to raise awareness of the importance of village chickens, to exchange experiences in chicken raising and to introduce the idea that small improvements in the husbandry of village chickens can make significant differences in productivity. The module also covered the characteristics of healthy and sick chickens, signs of ND, treatment of ND, how ND spreads, control of diseases including ND, vaccines, and vaccination of chickens against ND using I-2 ND vaccine. Specific training on how to organise and conduct vaccination campaigns was covered in a subsequent 1-day training course for community vaccinators.

Nutrition and feeding, and housing and shelter, were introduced during a 1-day training course. This was done so that the Mama Mkubwa could consider their individual home environments and resources, and plan for the small foundation flocks to be provided by the project. A further day of training in these topics was planned later in the year when the discussions about feeding and nutrition would also be used to discuss the components of a balanced diet for human families.

Modules on reproduction and marketing will follow once the flocks are well established.

Foundation flocks

Some Mama Mkubwa already had small flocks of village chickens and these women were key group members, sharing their knowledge and experience with the others. The project provided a small flock of four hens and one cockerel to each Mama Mkubwa. Although the women were initially interested in commercial chickens because of their perception of better productivity, village chickens were selected due to the lower cost of inputs required.

Chickens were purchased locally and quarantined for 1 week before distribution. During this time they were observed daily and vaccinated against ND using I-2 ND vaccine.

Vaccination campaigns

During the training in ND and ND control, it became apparent that ND is endemic in the area. The disease is well known and outbreaks occur mainly from April to June each year, with peaks of the disease in May.

Several of the women have been trained as community vaccinators and are planning to help their community and earn a small income through conducting vaccination campaigns against ND. The project was discussed with the district veterinary officer for Temeke district and he is keen to see vaccination campaigns conducted in the area, under the supervision of the local extension officer. Campaigns will be conducted three times a year following the schedule recommended by the Department of Veterinary Services. Monitoring and evaluation will be carried out after each campaign to help the vaccinators and their supervisor to identify and overcome problems that may have occurred. The women were planning their first vaccination campaign for January 2006.

Future plans

The women plan to set up a chicken revolving fund so that other disadvantaged and vulnerable families can also benefit from the project. During the community awareness raising activities planned before the first vaccination campaign, the women would be able to use their new knowledge to inform others in the community, particularly women, of ND and the importance of ND control.

Acknowledgments

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Avian influenza in smallholder chicken flocks

Paul Gilchrist¹

Abstract

Avian influenza virus occurs in a number of forms, some of which produce severe disease in chickens and turkeys. A recent outbreak in Asia is caused by a type of the virus that also affects other birds and humans. This virus has become endemic in some countries, and smallholder chickens and ducks may be hiding the virus and spreading it to commercial poultry and humans. With cases reported in a number of Asian countries, there is a risk that it may spread to other regions. A major danger for smallholder farmers is that forms with low pathogenicity may spread unnoticed and then mutate to highly pathogenic forms causing serious disease. Many cases of the disease have occurred in smallholder units in Asia and could well be a problem in other countries as it spreads.

The tools used to prevent and control avian influenza are:

- education—awareness raising and disease recognition
- biosecurity— isolation from infected and recovered poultry, wild birds, live-poultry markets, fomites (especially manure)
- early recognition—monitoring and diagnosis
- unofficial measures—voluntary quarantine
- official measures—diagnosis and stamping out (quarantine, slaughter, disposal and clean-up)
- vaccination— inactivated, recombinant, molecular and subunit vaccines.

The significance of these approaches for smallholder farmers is discussed.

Introduction

Avian influenza (AI) is caused by the avian influenza virus (AIV). This virus has long been known as the cause of severe disease (formerly called fowl plague) in chickens and turkeys. The virus also infects other domestic and wild birds, usually without producing signs. Wild birds, particularly waterfowl and including ducks, may become infected and carry the virus. (Gilchrist 2005). The virus is usually considered to be non-pathogenic to ducks (Selleck et al. 1994). The most commonly infected free-flying wild birds are waterbirds (ducks and geese) and waders. The recent outbreak in Asia

has also caused disease and deaths in ducks, free-flying wild birds and humans (Li et al. 2004) and a severe outbreak has been identified in migratory waterfowl in western China (Liu et al. 2005).

Avian influenza viruses isolated from chickens vary in pathogenicity and have, in the past, been grouped into mild pathogenicity (MPAI) and highly pathogenic (HPAI) types (Swayne and Halvorson 2003). More recently, however, the practice has been to describe all viruses that are not HPAI as low pathogenicity (LPAI) viruses (Alexander 2003).

The history of avian influenza and its control are well summarised in a review article by Swayne and Suarez (2000). The Asian outbreak is discussed in a more recent article (Anon. 2004).

The avian influenza viruses are classified into H and N groups based on their surface antigen structure with haemagglutinin (H) and neuraminidase

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(N) being the defining components of the groups. There are 15 H groups and 9 N groups. Most combinations of these groups have been found in domestic and wild birds, but only H5 and H7 types have been found in cases of severe avian disease. All the other H types (H1-4, H6 and H8-15) are of low pathogenicity for birds.

Within the H5 and H7 groups, most isolates are of low pathogenicity, but adaptation to chickens can lead to mutation from low to high, leading to some concern that spread of mild forms may be relevant to eradication methods (Alexander 2003). In addition, mutation to a form infective to humans has occurred in the H5 type in Asia, where H5N1 is the cause of the Asian influenza outbreak. This virus has become endemic in some countries, and smallholder chickens and ducks may be hiding the virus and spreading it to commercial poultry and humans.

There is a particular danger of genetic change in AI viruses from passage through pigs. If pigs are kept in close contact with infected poultry, the virus may infect pigs and undergo recombination with influenza viruses in the pigs. The chance of such viruses being a cause of serious disease in humans is thereby increased (Horimoto and Kawaoka 2001).

Low-pathogenicity viruses occur in wild birds (Mackenzie 1988; Easterday et al. 1997) and are maintained in wild aquatic bird reservoirs, occasionally crossing over to domestic poultry and causing outbreaks of mild disease (Halvorson 2002). High-pathogenicity viruses do not have a recognised wild bird reservoir, but can occasionally be isolated from wild birds during outbreaks in domestic poultry.

The accepted methods for dealing with HPAI viruses are prevention of exposure to the virus and eradication. Control programs that allow a low incidence of infection are not an acceptable method for managing outbreaks of severe disease but have been used during some outbreaks of mild disease. Vaccination has been used in control and eradication programs for some LPAI viruses (Swayne and Suarez 2000).

The H5N1 Asian AI outbreak appears to have different characteristics from earlier outbreaks and has involved some wild and domesticated waterbirds (Li et al. 2004).

A global strategy has been developed by the Food and Agriculture Organization of the United Nations

(FAO), the World Organisation for Animal Health (OIE) and the World Health Organization (WHO) (Anon. 2005a). This strategy includes recognition of the exposure of smallholder farmers to the ravages of the disease and their lack of resources to counter it. The strategy will include:

- improving animal health services at village level by means of organising community-based early warning networks, utilising the existing pool of para-veterinary village workers
- increasing farmers' general awareness through simple biosecurity guidelines on AI control using publications in local languages
- providing access to credit or microfinance as a tool for rehabilitation as an alternative to direct compensation, which some countries may not be able to afford
- developing farmers' groups and/or associations to help improve awareness and dissemination of information.

The involvement of private-sector organisations in assisting smallholders should not be overlooked, as the control of the disease in smallholder operations may be essential to protection of commercial poultry organisations.

Large populations of birds make a big target for viruses. Small farms offer a lesser target but can still become infected. Small farms may hide the virus between outbreaks or spread it between commercial farms during an outbreak. Live-bird markets, semi-feral poultry and fighting cocks may all be involved in virus spread. Placing susceptible birds in contact with other birds that may be infected, then returning them to the home unit increases the risk of infection being introduced. Many countries with smallholder chicken flocks held in villages have become, in effect, covered by a thin carpet of semi-feral village chickens.

Fighting cocks are of particular concern in causing human infection because of the intimate level of contact that may occur between humans and these valuable birds. There are anecdotal accounts of fighting cocks that appear to have been injured in a fight, being treated by the owner sucking on the bird's nasal passages to remove sinus secretions. If such a bird were infected with HPAI it is obvious that the risk of human infection is high.

The prevention and control of AI can be achieved by the following methods:

- education—awareness raising and disease recognition

² Sixteen H groups are now recognised.

- biosecurity— isolation from infected and recovered poultry, wild birds, live-poultry markets and fomites (especially manure)
- early recognition— monitoring and diagnosis
- unofficial measures— voluntary quarantine
- official measures— diagnosis and stamping out (quarantine, slaughter, disposal and clean-up)
- vaccination— inactivated, recombinant, molecular and subunit vaccines.

A discussion of each of these follows.

Education

Awareness raising and disease recognition are crucial. AI has been a rare occurrence until the recent Asian epidemic and may not be either recognised or considered important in many countries. Awareness raising and disease recognition may be issues in such areas. The severity of signs may vary and the implications for the owner of affected, or even merely exposed, birds are serious, and many producers may be fearful of the consequences of admitting that the disease may have occurred. Attempts at hiding the disease may facilitate its spread.

Education strategies should include awareness raising through mass media, school and community programs (in youth and women's organisations) and involving local technical people in surveillance and training activities.

Educational strategies are discussed in Anon. (2005b).

Biosecurity

Healthy chickens must be isolated from infected and recovered poultry, from wild birds, from live-poultry markets and from fomites (especially manure).

Poultry farming systems may be classified into four levels of biosecurity along the lines of the sectors proposed by FAO (Anon. 2004):

- Sector 1. High biosecurity industrial integrated systems
- Sector 2. Moderate to high biosecurity commercial systems
- Sector 3. Low to minimal biosecurity commercial systems
- Sector 4. Minimal biosecurity village or backyard systems.

It is the fourth sector type that is the subject of this paper. The relevance of the comparison between

these systems is to emphasise the high level of exposure to the virus that may occur in smallholder poultry systems. The impact of an incursion of the virus on sector 1 or 2 may be much worse, because of the high number of birds involved and because the opportunity for a large number of virus multiplications in a short time is much higher. This high number of rapid multiplications favours the development of genetic change, including the possible change from low to high pathogenicity.

While smallholder chicken-farming operations have lower numbers of susceptible birds exposed to the virus, they still offer an opportunity for LPAI viruses to mutate to HPAI forms by passage through chickens. This is especially a concern because LPAI forms may not cause sufficient signs of disease to allow them to be recognised.

The smallholder operations may be physically more exposed to domestic or wild birds carrying the virus. Spread to or from neighbouring smallholder units may occur easily.

They are also more likely to be associated with live-bird markets where newly bought or unsold birds that have been exposed to the virus are taken home to an operation where susceptible birds are present. The lower number of birds involved, however, imposes a limit on the number of multiplications that may occur, thus reducing the chance of genetic change occurring and leading to further spread of LPAI.

Equipment used for transporting eggs or birds to or from the market may also be contaminated on return to the unit. People moving between infected and susceptible birds are also possible carriers of virus.

Early recognition

Rigorous monitoring and early diagnosis of diseases are essential. If official eradication procedures are applied as a result of an outbreak in commercial poultry, it is likely that birds on smallholder farms may also be killed off to stop virus spread. The cost of such slaughter may be very serious for a smallholder farmer.

The H5 type may spread from poultry to humans so it is important for all poultry farmers to avoid close contact with infected birds. If the virus becomes established in people there is a very real danger that it could adapt and become a serious human disease.

Signs of AI vary a great deal. The clinical and autopsy signs of the disease vary with the patho-

genicity of the virus, the species affected and its sex, age, concurrent infections and acquired immunity, and environmental factors. LPAI causes a low mortality rate but clinical signs may be common. They may cause depression, loss of production, oedema, necrosis and haemorrhage of the comb and wattles, and respiratory signs including pneumonia, rales, coughing and sneezing.

In chickens and turkeys, HPAI may cause sudden death with no clinical signs. Less severely affected birds may show nervous signs with tremors of the head and neck, weakness or unusual positioning of the head, wings and legs. There may also be some lesions of the comb and wattles. Birds may be depressed, quiet and stop laying.

Diagnosis can be confirmed only by laboratory tests, including antibody, antigen or virus detection. In such a critical disease it is important to have diagnostic facilities available in advance. Recognition of the earliest cases is most important if there is to be any hope of successful eradication. As early cases may be caused by LPAI, the significance of diagnostic facilities becomes even more important. Monitoring by sampling flocks over a wide area is important in establishing a baseline of information to allow evaluation of isolations made in a suspected outbreak.

Differential diagnosis may be important. A number of other diseases may show signs that can be confused with AI. Fowl cholera and Newcastle disease are prominent among these. Other causes of respiratory signs with or without sudden death must also be considered, including laryngotracheitis, coryza and mycoplasmosis. Diseases such as infectious bursal disease or coccidiosis may cause sudden deaths in young birds and, if some respiratory disease is also present, there may be confusion.

The OIE has developed a 'Manual of diagnostic tests and vaccines for terrestrial animals' (Anon. 2005d).

Unofficial measures

Voluntary quarantine may benefit smallholders. The risk for individual smallholders is that the identification of the disease in their flock may lead to loss of face in the community or to slaughter of their poultry by authorities. With H5N1 HPAI there is the additional danger of human infection to consider. Covering up the infection adds to the likelihood of spread to humans.

To protect susceptible birds, smallholders may benefit from the voluntary imposition of quarantine, with complete restriction of the entry of virus from outside the area. There is some point in improving the isolation of their flock by preventing movement of live birds, people, equipment and poultry products into the area.

Once an outbreak occurs in a smallholder flock or area it seems unlikely that eradication will be successful without the persuasive effect of incentives and penalties at an official level. An exceptionally altruistic and well-educated community of smallholders would be needed to expect successful eradication. Smallholder operations normally depend upon the movement of live birds, people, equipment and poultry products. A complete standstill is unlikely to be effective. The spread of disease is unlikely to be controlled unless an all-in, all-out system including a single age of birds in all units in a neighbourhood is applied.

If compensation is not provided, there is a strong incentive to dispose of affected birds as profitably as possible. In many cases, rapid sale of suspect birds would appear attractive and thus further spread of virus could occur. The downside of a compensation scheme is that some producers are encouraged to spread the disease to their flock in order to get access to funds that may not otherwise be available during an outbreak.

Unofficial measures to control an outbreak are likely to be counterproductive. Vaccination is probably the only thing a smallholder can do. The risk of using unauthorised vaccines must be understood and discouraged.

Pigs that are housed with poultry are a particular danger as recombination of AI viruses from poultry and pigs is likely to result in the emergence of a human pathogen. Smallholders could well reduce their exposure to such a virus by separating pig and poultry production, and limiting access of smallholder poultry to wild birds (Horimoto and Kawaoka 2001).

Biosecurity can be improved for a smallholder farmer by housing chickens in small flocks in bird-proofed colony cages with a raised floor. There should be no scavenging (semi-feral) poultry having access to the area in the vicinity of the cage. This type of housing has the added advantage of controlling other endemic diseases and thus improving productivity of the flock. Further improvement in biosecurity is made possible by purchasing started

chickens (16 weeks of age) from a reliable, disease-free source, and keeping them in a single age group and replacing all of them at the end of their productive life with a new group.

The establishment of an industry sector based on the application of such biosecurity principles and other appropriate technology practices is a feasible way of improving poultry productivity. Improved housing, nutrition, biosecurity (isolation, clean drinking water etc.) and disease control (such as Newcastle disease vaccination) are discussed in Gilchrist (2009).

Official measures

In most cases of an initial incursion of HPAI into an area that has been free of the virus, the authorities will respond by attempting to stamp it out. This involves having an agreed eradication plan including a legal basis for action, penalties and compensation. The plan should have been subjected to simulation exercises in advance to ensure that all participants are aware of, and equipped for carrying out, their responsibilities. The FAO has developed a ‘Good emergency management practices code for disease emergencies’ (Anon. 2005c).

The campaign should recognise that live, infected birds are the major source of infection. Dead birds and contaminated people, equipment and faeces are also a risk but much less so. This means that containing and killing live, affected birds is the first priority.

The critical elements of an eradication campaign are:

- identification—confirming that the condition is HPAI
- quarantine—declaration of a quarantine area around the outbreak area
- standstill—halting of all movements of poultry, people, equipment and poultry products from the area
- slaughter—humane euthanasia of affected or close-contact birds
- carcass disposal—sanitary disposal of carcasses by burning or burying
- clean up—removal of faeces and litter, and cleaning and disinfection of premises and equipment
- compensation—provision of compensation, which is essential to encourage compliance
- other costs—consideration of the social and economic costs of an outbreak

- human safety—protection of smallholders and control personnel from infection
- investigation—diagnostic and monitoring activities.

Wild birds may be infected with virus in an outbreak but there be uncertainty if they are the source of infection or have become infected by contact with affected poultry. Attempts to prevent or control an outbreak by slaughter of wild birds appear to be unwarranted in the light of current knowledge. In any case, it is likely to be impossible to eliminate all members of a wild-bird population. Some protection can be obtained by providing added biosecurity measures such as bird proofing poultry housing and ensuring that drinking water is clean or adequately sanitised.

Vaccination

Vaccines must be manufactured according to the international manufacturing and quality control standards described in the ‘OIE manual of standards for diagnostic tests and vaccines’ (Anon. 2005d).

Stamping out remains the preferred means of control of HPAI but vaccines may be useful in control of the disease. There are three possible strategies for vaccine use:

- vaccination in response to an outbreak
- vaccination in response to a ‘trigger’ such as an outbreak in wild waterfowl
- preventive vaccination of all or part of a population of poultry when the likelihood and/or the consequences of an incursion is high.

A vaccine must be developed specifically for the type of virus involved in a particular outbreak. Use of vaccines to control the disease is contentious. Some experts feel that vaccinating hides the disease and hinders eradication. Others feel that vaccination reduces the level of excretion of virus particles and thus enables farmers to continue production while other control measures are adopted.

Most use of vaccines in Europe and North America has been to control LPAI viruses and may not be applicable to HPAI. Vaccines have been used successfully, in combination with other measures, to control H5N1 HPAI viruses in Hong Kong.

Several effective commercial vaccines are available. They provide protection against clinical disease and reduce mortality and the effects of disease on production. Most birds in a flock are also protected from infection. Those birds that remain

unprotected may still shed virus but shedding is reduced in both duration and quantity. This reduces the chances of infection of birds and humans.

Most current vaccines are inactivated, whole-virus antigen in oil-based emulsion adjuvant. A live recombinant fowlpox with H5 AI gene insert has been used in some countries.

A list of vaccines is available on the internet (Elkin 2005).

Vaccinated birds contain antibody and thus may not be accepted for international trade in live birds or poultry products as they cannot be easily differentiated from recovered (and possibly infected) birds.

Vaccines against H5 virus must contain the H5 antigen but may contain the same (N1) or other N antigens. If different N antigens are used it may be possible to differentiate between recovered and vaccinated birds.

The disadvantage of inactivated vaccines is that their efficacy is determined largely by the mass of antigen that can be administered parenterally. Catching and handling each bird is difficult and costly. Achieving a high antigen dose is also often a problem. Live virus can be administered by less difficult methods including orally in drinking water and by spray application. The live virus will multiply inside the bird and thus antigen mass is less important.

Several other vaccine types are being developed, including adenovirus-vectored vaccines that can be administered in the drinking water and Newcastle disease vectored types that can be administered as a spray. Molecular and subunit vaccines are also being considered but are some way off being available.

Training of vaccination teams is most important to ensure efficacy, safety and the production of good records of vaccines used and birds vaccinated.

The use of vaccine may be considered in those cases where the likelihood of an incursion of HPAI is high, where there is a high poultry density and where improved biosecurity is not possible and control by stamping out is unlikely. Vaccination in such cases may minimise virus propagation, protect susceptible birds and reduce the risk to human health.

While the efficacy of vaccine in other poultry species is unknown it seems reasonable to vaccinate such birds held in contact with smallholder chickens when the latter are being vaccinated.

Conclusion

As the H5N1 virus is still spreading geographically and changing genetically it is important to follow its path by referring to the OIE website for current developments.

It is likely that control measures will change as experience with the disease develops. Stamping out will usually be applied in the event of an initial incursion of HPAI in a country or region but vaccination may be introduced as an added tool if the first response appears inadequate.

A country or region that is free of HPAI should review conditions for importation of fertile eggs, live poultry and poultry products and equipment in order to improve the biosecurity level.

The epidemic of H5N1 also has an important public health dimension, with the death to date of a number of people, giving rise to serious concern about the potential for emergence of a pandemic strain of human influenza virus through reassortment of avian and, potentially, pig influenza viruses.

It is now clear that H5 HPAI viruses are endemic in parts of Asia and that the existence of reservoirs of infection in ducks and, potentially, wild birds and pigs, presents a serious challenge to eradication.

These factors highlight the necessity for countries infected with or threatened by HPAI viruses to implement appropriate measures for prevention and control. It is equally important that FAO and international organisations continue to collaborate with donors and affected countries in identifying and implementing strategies for recovery and rehabilitation of countries affected by HPAI (Anon. 2004).

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