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Improving farmyard poultry production in Africa: Interventions and their economic assessment

Proceedings of a final research coordination meeting organized by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and held in Vienna, 24–28 May 2004

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FOREWORD

A major objective of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture is to support research projects involving nuclear and related techniques leading to improved animal production in developing countries. Chicken produced on a relatively small scale, at the farmyard level, are an important source of animal protein for human consumption in developing countries. Limiting factors to maximize this resource include infectious diseases and overall production management. A Coordinated Research Project on Small Scale Poultry Production was initiated in 1998 to evaluate the impact and cost efficacy of inputs in management and veterinary care and provide guidelines to improve the livelihood of farmers.

This publication contains the results of the FAO/IAEA Coordinated Research Project entitled Assessment of the Effectiveness of Vaccination Strategies against Newcastle Disease (ND) and Gumboro Disease (IBR) using Immunoassay-based Technologies for Increasing Farmyard Poultry Production in Africa. Thirteen research contract holders in Africa evaluated the major constraints to poultry production in different regions of their countries, analysed the disease situation, management and marketing practises and developed improved ND vaccination and husbandry strategies with the support of the four research agreement holders. This exercise highlighted the added benefit strategic vaccination had on the survival rate and the number of birds produced. A thermostable ND-vaccine seed strain (provided by CSIRO, Australia) reduced the cost of vaccination substantially, as it could be produced locally, with the added advantage of being thermo-resistant, thus reducing the need of a prolonged cool chain. This was further improved by the training of “village vaccinators” performing vaccine inoculations without the need of veterinary staff on place, insuring vaccination frequency. The efficacy and the level of protection resulting from vaccination were evaluated based on antibody titres. Management of chicks (overnight housing and creep feeding) for the first six weeks improved production by a further 30%. The holistic approach, i.e. vaccination together with management strategies, improved the survival of chicks by more than 80%. It was also noted that women were playing an important role in the daily management of backyard poultry. Furthermore, IBR and fowl pox infections had an adverse impact on production in several locations, but never to the extent seen for ND. For these situations, specific prophylactic vaccination programmes were developed. The use of the isotope related technique ELISA for assessing disease status and vaccination protection was key to the success of this CRP.

This TECDOC provides insight into the constraints faced by the informal farmyard chicken production sector in Africa and describes strategies to overcome these limitations. Lessons were learned and applied from a Bangladesh study that first identified, evaluated and classified factors influencing poultry production before intervention. The results obtained through this CRP are encouraging and will certainly help to increase poultry production in general and improve the livelihoods of the rural poor. In the summary you will find the condensed results obtained with methods explained in the expert presentations. The country reports contain all background data.

The FAO and IAEA wish to express their sincere appreciation to the participants of this CRP for their contribution to the CRP and the present publication. The IAEA officer responsible for this publication is H. Unger of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

EDITORIAL NOTE

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Abstract

In an FAO/IAEA Coordinated Research Project on backyard poultry production in Africa 13 laboratories all over this continent cooperated with seven research agreement holders to determine and quantify specifically limiting production factors in this economic niche. Infectious diseases and in particular Newcastle disease was major constraint. Lack of management practises added losses mainly in young birds. The introduction of a new thermostable Newcastle vaccine produced easily in eggs and applied by village vaccinators brought enormous economic advantages specifically where chicks were managed for the first month after hatching and in most locations this could double the income generated.

1. INTRODUCTION

The final Research Coordination Meeting (RCM) of the FAO/IAEA Coordinated Research Project (CRP) "Assessment of the effectiveness of vaccination strategies against Newcastle disease (ND) and Gumboro disease (IBR) using immunoassay-based technologies for increasing farmyard poultry production in Africa" was held at the IAEA in Vienna, Austria, 24–28 May 2004. The meeting ended a five-year programme and was attended by research contract holders from Cameroon, Egypt, Ghana, Côte d'Ivoire, Kenya, Madagascar, Mauritius, Morocco, Mozambique, Sudan and Tanzania and research agreement holders from Bangladesh, Denmark, the Netherlands and Tanzania. Two counterparts were absent (Uganda, Zimbabwe). The progress and results of this CRP were discussed, assessments of partial budget analyses were performed and the various interventions such as ND and IBR-vaccinations, anti-parasitic treatments and improved management practices, were ranked according to their effectiveness. Participants all agreed that the CRP outcome would be beneficial to the respective national poverty alleviation programmes.

2. BACKGROUND

Poultry research initiated by the Joint Division FAO/IAEA

Initial activities

An initial policy paper was produced by Barbara van der Eerden in 1996 that suggested expanding the programme of the Animal Production & Health section to include research activities on poultry. Two consultants, Anders Permin and Jonathan Bell, in close collaboration with the staff of the Animal Production & Health Section, outlined the next year a proposal for a research project on family poultry production in Africa. The research project was designed with a holistic approach for the improvement of family poultry production in

Africa. External funding was sought from various donors, but proved difficult to obtain for geographical reasons. Most donors at the time were concentrating their support efforts on a single country or a relatively small region. By 1998 the Joint FAO/IAEA Division decided to initiate the research on poultry using funds available through the Coordinated Research Programme (CRP). The unique feature of a CRP is that with modest amounts of funds (US$ 5000–8000 per contract holder) a number of scientists in different countries are able to initiate applied research on the same subject using a similar approach in a coordinated fashion. The results of a CRP will usually highlight the differences and similarities between production systems of uniquely dissimilar environments and management approaches. Coordination is facilitated by annual meetings (called Research Coordination Meetings or RCM's) where scientists can present and discuss the results of research. At the same time a number of experts on the subject (called Research Agreement holders) are involved in the CRP to provide assistance and advice during the entire length of the programme.

Coordinated research programme on poultry

The chief scientific investigators of the thirteen African institutes are listed in Table I and the geographical distribution is shown in Fig. 1.

TABLE I. RESEARCH CONTRACT HOLDERS.

Country	Institute	CSI*
Cameroon	Institut de Recherche Agricole pour le Développement, Bamenda	F. Ekue
Côte d'Ivoire	Laboratoire Central de Pathologie Animale, Bingerville	T. Danho
Egypt	Animal Health Research Institute, Cairo	A. Amin/A. Azzam
Ghana	Accra Vet. Lab., Accra	J. Awuni
Kenya	Central Vet. Lab., Kabete	S. Njue
Madagascar	Departement de Recherches Zootechniques et Veterinaires, Antananarivo	M. Koko
Mauritius	Agric. Res. Ext. Unit, Reduit	V. Juggessur
Morocco	Institut Agron. et Vet. Hassan II, Rabat	F. Kichou
Mozambique#	Instituto Nacional de Investigacao Veterinaria	Q. Lobo
Sudan	Univ. of Khartoum	A. Khalafalla
Uganda	Livestock Health Research Institute, Tororo	J. Illango
United Rep. of Tanzania	Animal Disease Research Institute, Dar-es-Salaam	H. Msami
Zimbabwe#	Central Veterinary Laboratory, Harare	J. Nqindi

* CSI = Chief scientific investigator;
# indicates that the scientist could not participate for the entire length of the five-year programme.

The Research Agreement holders (Table II) assisted in the design of work plans including the development of a standard protocol to collect field data during the first two years, and gave critical comments on the annual and final scientific reports of each scientific investigator.

TABLE II. RESEARCH AGREEMENT HOLDERS.

Country	Institute	RAH*
Denmark	Royal Veterinary & Agricultural University, Frederiksberg	A. Permin
Netherlands	Fort Dodge Animal Health, Weesp	F. Davelaar
Netherlands	National Inspection Service for Livestock and Meat, The Hague	R. Dwinger
USA	University of Wisconsin, Madison	B. Goodger
United Rep. of Tanzania	Sokoine University, Morogoro	U. Minga
Nigeria	Obafemi Awolowo University, Ife-Ife	E. Sonaiya
Bangladesh	Danish International Development Agency: smallholder livestock development project	J. Bell

* RAH= Research agreement holder

The Research Contract Holders received each year, over a five-year period, a moderate amount of funds to enable them to initiate applied research on family poultry production according to their work plans in their countries. The first two years were used to gather baseline data on production characteristics of family poultry. The results have been published in 2002 as an IAEA TECDOC (Characteristics and parameters of family poultry production in Africa, ISBN 90–5782–094–3). The next three years of the CRP were devoted to interventions in order to improve poultry production at the village level. The interventions included vaccination of birds against Newcastle disease, Gumboro disease and fowl pox, improvements in housing and feeding strategies and serological monitoring in order to select the most suitable time for vaccination and assess the effectiveness and level of protection.

FAO/IAEA Coordinated Research Programme to improve family poultry production in Africa

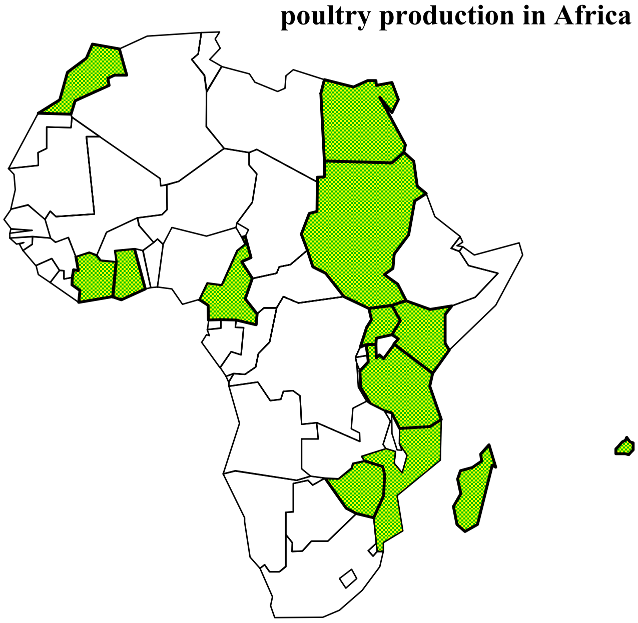

FIG. 1. Map of Africa showing the countries participating in the Coordinated Research Programme on family poultry in Africa.

During the five years of the programme a total of four Research Coordination Meetings (RCM) were organized (Table III). The first RCM was organised in Rabat, Morocco, and was devoted to developing a standard protocol for collecting baseline data in the various countries on family poultry production. The details of the standardised data collection sheet are shown in Table IV. During the second RCM, that was convened in Morogoro, United Republic of Tanzania, the results were presented and discussed and protocols for vaccination strategies were developed. It was decided to concentrate on using the thermostable I-2 vaccine, because it would simplify distribution to the villages since maintenance of the cold chain is of less importance. A number of investigators decided to compare the effectiveness of different vaccines or applications (e.g. reports from Egypt, Ghana and Madagascar).

TABLE III. DETAILS OF THE RESEARCH COORDINATION MEETINGS (RCM) HELD.

Meeting	Location	Date	Number of participants
First	Rabat, Morocco	8–12 February, 1999	10 RCH, 5 RAH, 3 observers
Second	Morogoro, Tanzania	4–8 September, 2000	12 RCH, 6 RAH, 8 observers
Third	Port Louis, Mauritius	4–10 May, 2002	11 RCH, 6 RAH, 3 observers
Fourth	Vienna, Austria	24–28 May, 2004	11 RCH, 5 RAH, 2 observers

At the third RCM held in Mauritius, the type and details of other interventions in family poultry production such as feeding, housing and de-worming, were discussed following the presentation of the vaccination and serology results. Suitable intervention strategies to improve family poultry production were tailored towards each scientist's local requirements and individual work plans were prepared. During the fourth and final RCM organised in Vienna, Austria, the final scientific reports were discussed and refined and plans for future activities concerning poultry production were developed.

TABLE IV. DETAILS OF THE STANDARD PROTOCOL USED TO COLLECT FIELD DATA ON THE CHARACTERISTICS AND PARAMETERS OF FAMILY POULTRY PRODUCTION.

GUIDELINES FOR FIELD WORK
1. Select 2 different ecological zones (maximal a two-hour drive away from the lab.).
2. Select 3 villages in each zone.
3. Select 4 (female) farmers, which keep family poultry, in each village.
4. Visit the village to explain your plans (research project, interventions at a later stage to improve food security) to the village elders/chief.
5. Make appointments with farmers to return at a later date for a farm visit.
6. Test the survey in the field before use (also when you translate it in the local language).
7. Use the survey when talking to the caretaker.
8. Observe the birds and make diagnoses on the spot.
9. Collect some (preferably fresh) faecal samples.
10. Collect blood samples from 6 adult animals on each farm and prepare serum.
11. Store each serum sample in two aliquots at –20ºC or –80ºC
12. Buy the sick birds to do autopsy in the laboratory.
13. Employ a veterinary assistant living in the village to visit the farm more often to provide you with additional sick/dying birds (this is obviously not possible in every village).
14. Repeat the whole exercise a second time during the dry (or wet) season.

During each of the meetings a number of observers involved in poultry research or related subjects were invited and managed to attend (Table V).

TABLE V. INTERNATIONAL OBSERVERS.

Country	Institute/Organisation – City	Name of Observer
Australia	University of Queensland – Brisbane	P. Spradbrow
Australia	Commonwealth Scientific and Industrial Research Organization. – Melbourne	A. Gould
Denmark	Dept. of Anthropology – Frederiksberg	M. Whyte
Denmark	Danish International Development Agency; poultry project – Frederiksberg	G. Pedersen
Italy	Animal Production and Health Division, FAO, United Nations – Rome	R. Branckaert/ A. von Krogh/ E. Guerne Bleich
Mozambique	National Vet. Research Institute – Maputo	R. Alders/ M. Harun
UK	Avian Sciences Research Centre – Auchincruive	T. Acamovic/ N. Sparks
UK	Veterinary Epidemiology and Economics Research Unit – University Reading	R. Oakeley

These scientists presented results from other poultry research projects in Benin, Eritrea, Malawi, Mozambique, Zimbabwe, Bangladesh and India. In addition reports were given on the molecular epidemiology of ND using fusion gene cleavage sequencing to distinguish different virus strains and the anthropological implications of family poultry production. Other presentations focussed on how to write a scientific article or explained how to request funds from the IAEA in a successful manner. Reviews were presented on the different vaccines available for the control of Newcastle disease, on parameters for the assessment of the scavengeable feed resource for poultry and on the development of a sustainable Newcastle disease control programme including the development of an extension package.

3. ACHIEVEMENTS

Production characteristics and parameters

Production parameters and characteristics of family poultry production have been compiled and published for eleven African countries (Characteristics and parameters of family poultry production in Africa, IAEA 2002). The current publication focuses on results of various interventions in family poultry production. All of the investigators included vaccination against Newcastle disease, while additional interventions ranged from providing housing using locally available materials and feeding strategies for different age groups to improving health of the birds through additional vaccinations and/or parasite treatments.

Diagnostic techniques

At the FAO/IAEA Biotechnology Laboratory in Seibersdorf, Austria, a consultant in collaboration with staff from the Animal Production Unit and the Veterinary University Vienna developed a standardised and robust enzyme-linked immunosorbent assay (ELISA) for detecting antibodies against Newcastle disease in poultry. The ELISA was distributed to a number of selected scientists in the form of a ready-to-use kit. The kit was successfully used in laboratories in Cameroon, Kenya, Sudan, Tanzania, Uganda and Zimbabwe to assess the effectiveness of vaccination or to evaluate the epidemiological situation in the village birds. The laboratories in Madagascar and Tanzania compared antibody levels in serum samples from vaccinated birds in the field using the ELISA technique with results from the haemagglutination inhibition test.

Antibody levels against Gumboro disease were assessed using a commercial test kit in Egypt, Madagascar and Sudan.

Financial evaluations

All investigators were requested to apply a partial budget analysis to the results of the interventions used in the different ecological zones. A format and detailed instructions on its application were provided to the scientists. The partial budget calculates the incremental income based on the intervention (starting from the baseline income before the intervention). The results for each country are presented in the current publication.

4. RESULTS

The most critical intervention was strategic vaccination against ND that reduced mortality in chicken by up to 80%. All projects demonstrated a positive economic return from this prophylactic intervention that increased with the use of locally trained people acting as "village vaccinators". Interventions such as feed supplementation, anti-parasitic treatment or improved housing were only effective when used in conjunction with vaccination, and in these cases benefits were demonstrated. It is furthermore recommended that strategic vaccination should be introduced, preferably using a thermostable vaccine to avoid problems with the cold chain. While vaccination against IBR or Fowlpox was shown to have a beneficial effect on production; logistical problems with the administration hamper its application. Depending on specific local conditions, supplementary feeding and housing of chicks, optimising flock composition (e.g. 10 hens, 3 cocks, 150 chicks, 150 growers) and strategic anti-parasitic treatment of housed poultry can have complementary effects. Surveys highlighted the involvement and the unique role of women in poultry production. Consumer diet preference underlined the potential of farmyard poultry production based on local breeds.

Economic Importance and Ranking of Interventions

The interventions investigated were ranked according to their economic importance. In the second RCM it was concluded that partial budget analysis and local needs should dictate the priority or ranking given to interventions on disease, management or breeds:

Disease

Disease control was regarded as the most important intervention and the following parameters were considered:

- **A vaccination strategy** must be adapted to the local requirements based on proper diagnosis and epidemiological factors. As there is a seasonal occurrence of ND, it is advisable to vaccinate the chicks within the first 4 weeks after hatching with boosters every 4 months thereafter.

- **A thermo-stabile ND-vaccine** is an important prerequisite to reduce the costs for the cold chain. The propagation of the I2-vaccine is done in chicken eggs. Thermo-stability of the freeze dried formulation is estimated at a minimum of one year at 4 degrees Celsius and several weeks at 28 degrees Celsius. The production of 100 dose vial quantities should be encouraged to accommodate use of family poultry owners.

- **Quality assurance**, both in production and in application is important to ensure the efficiency of the vaccination programme. The production laboratory must avoid contamination and seek optimum dilution of the virus suspension in a protective buffer. The proper application and vaccination coverage should be monitored by serology (ELISA).

- **Local government buy-in and community involvement** are essential for successful and efficient vaccination programmes. As poverty alleviation is a national goal, administrations should encourage the local production and dissemination of this vaccine. The quality control should be outsourced not to create a conflict of interest.

- **Cost recovery** must be included in the vaccination programme. The production cost of the vaccine is rather low with the main costs stemming from bottling and distribution. Investments for quality assurance and the monitoring of protection in the field should also be included in the total vaccine price.

- A **holistic vaccination approach for** ND in combination with IBR or/and Fowl-Pox increases the efficiency and acceptance of poultry vaccination programmes in the rural communities.

- **Diagnostics** are important components of disease control and upgrading infrastructure and diagnostic capability of the responsible institutions are essential. Only the constant monitoring of the disease situation and the virus strains circulating will allow timely and effective interventions.

Management

Improvement of poultry management has a significant influence on the reduction of chick mortality.

- **Creep feeding** and assessment of local versus commercial feed resources for the first 4–6 weeks reduced mortality remarkably. Feed supplementation of chicks improves the growth of chicks and in parallel resistance to infection and parasites. At the same time it reduces the movement and thus the risk due to predators.

- **Improved housing** had a positive impact due to reduced predator access, specifically at night.

- **Management training** of the smallholder was considered essential. As backyard poultry farming is seen as a “hobby”, investment in this activity is uncommon. The public must be made aware that small investments in vaccinations and improved management can yield significant returns in increased income.

- The influence of breeds and genetics was considered important but not investigated in this CRP.

Conclusions of the CRP

The conclusions from the research results presented at the final RCM were:

- Strategic ND vaccination reduced mortality up to 80%
- Partial budget analysis showed a substantial return on investment for ND vaccination of village chicken in all countries
- Only in ND vaccinated birds did feed supplementation and anti-parasitic treatment show an additional positive return
- Other interventions such as housing had a complementary effect
- Farmyard poultry production was generally managed by women

Recommendations and future implications of the CRP

The meeting led to the following recommendations:

- Strategic vaccination and a treatment programme should be introduced for each country with strong local support through village vaccinators
- Local vaccine production (preferably thermostable) with suitable quality control measures should be supported and vials of 100 dose quantities would be advantageous
- Local conditions and by-products should be evaluated to assess supplementary feeding requirements of chicks
- The ideal flock composition is 10 hens, 3 cocks, 150 chicks, 150 growers
- After hatching, chicks should be removed to allow creep feeding in order to increase the clutching cycle
- Country specific extension documents/guidelines on the production of poultry should be produced and promulgated
- The interaction and collaboration between veterinary and extension services, farmers and other stakeholders (NGOs) should be promoted
- Local Farmer Associations should be organized to allow for a better access to vaccines and drugs and to improve marketing
- The possibility of developing chicken breeds resistant to the major poultry diseases (in particular Gumboro) should be investigated

5. CONCLUDING REMARKS

The farmyard production of poultry is seen as a profitable enterprise according to the findings of this CRP. It not only has the potential to reduce poverty of the rural poor, but also add to their sustainable food resources. Necessary inputs to benefit fully from small-scale production are vaccines and their delivery, feeding and management skills. Women, as the main producers of chicken, bear the burden of these small-scale enterprises. The respective veterinary authorities are asked to secure the availability of vaccines and to promote the management practices shown to be profitable in the rural communities and farmers associations. The production of a manual translating the results of this CRP into laymen terms would certainly support this informal sector.

EXPERT PRESENTATIONS

USE OF A STANDARDIZED FORM FOR PARTIAL BUDGET ANALYSES TO ASSESS THE FEASIBILITY AND EFFICIENCY OF INTERVENTIONS IN FAMILY POULTRY OPERATIONS IN 11 AFRICAN COUNTRIES

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Abstract

The economic evaluation of interventions in management and health of chicken in a backyard production system depends on strict rules for the data acquisition. Here we describe a form for sampling data for partial budget analysis. Eleven countries supplied sufficient data to calculate the economic benefit of certain interventions. For core interventions like Newcastle vaccination, feed supplementation and improved housing of chicks, the return of investment had a factor of 3 to 6, but reaching 18 when vaccine was administered by the farmer. The research contract holders successfully used the data acquisition form and all economic data in this publication are based on it.

INTRODUCTION

Family poultry production in many rural areas of Africa is an important source of food and income as well as a major source of protein; unfortunately there have traditionally been many constraints on production. Village poultry production is a low input system with little investment on disease control and prevention, supplemental feed or housing and results in low output from high losses and low production.

An FAO/IAEA funded five year coordinated research project (CRP) was initiated in 1998 to study family poultry in 12 African countries and to then suggest and initiate appropriate intervention strategies that are economically viable. The first phase of the project involved surveying village farmers to assess needs and shortcomings and to formulate plans for the intervention phase [1]. Village surveys indicated that three of the top four most commonly reported clinical signs of disease (greenish/bloody diarrhoea, swollen head, and coughing) are also signs of Newcastle disease [2]. Other contributions in this current publication outline all the specific intervention strategies that were initiated; however, vaccination against Newcastle disease virus was a component of intervention in each of the 12 participating countries. Other interventions included supplemental feeding, improved housing, control of parasites, vaccination against infectious bursal disease virus (Gumboro Disease) and against Fowl Pox.

An important aspect of the second phase was to conduct a partial budget analysis on the interventions to determine their viability in the future. Profitability of new management strategies is pivotal to there recommendation for future use.

MATERIALS AND METHODS

The chief scientific investigators were provided a set of guidelines for calculating economic parameters including profit and return on investment and a sample partial budgeting form (Table I) was provided [3]. 11 countries have provided economic data for each of their intervention strategies. The steps outlined for farm budgeting are:

- Establish baseline data so additional income received from the intervention strategies can be calculated
- Calculate additional (increased) income from the intervention strategies by calculating the difference between income while on the programme from estimated income before the programme
- Additional (increased) Income = Income while in programme – Income before the programme
- Estimate the programme costs by itemizing and adding the costs of each input
- Determine the profit by calculating the difference between the additional income generated and the programme costs
- Profit = Additional Income – Programme Costs
- Determine the return on investment of the intervention programme by dividing the additional income by the cost of the programme
- Return = Additional Income / Programme Costs
- The criteria for a successful intervention is a dollar income >$1(profit) or a return >$1

TABLE I. SAMPLE PARTIAL BUDGETING FORM.

Partial Budgeting Form (cash flow) Name of Country: Date:			
INCREASED CASH VALUE		INCREASED CASH REQUIRED	
Additional Cash Incomes		Additional Cash Costs	
Example: adult and growers sold		Example: –Newcastle vaccine cost –Labour to give vaccination –Material Costs for wicker baskets –Labour to make wicker baskets	
Increased cash income $________		Increased cash costs $________	
Total cash income $________		Total cash costs $________	
Cash income minus cash costs (profit) $________			
Cash income divided by cash costs (return) $________			

RESULTS

Partial budget analyses of intervention strategies were provided by 11 counties (Cameroon, Côte D'Ivoire, Egypt, Ghana, Kenya, Madagascar, Mauritius, Morocco, Sudan, Tanzania and Uganda). In order to compare outcomes and profitability between various countries with different monetary systems the economic analysis was converted to United States dollars (US $) so interpretation of results could be made on an equivalent scale. Cameroon, Côte D'Ivoire and Ghana did not provide their partial budgets in US $ so conversion rates from 2002 and 2003 were obtained. The exchange rate for Cameroon was set at 611.24 CFA francs per US $ by calculating the average exchanges rate from January 2003 through March 2003, which was the period when on-farm monitoring and collection of data was being conducted. The period of interventions for Côte D'Ivoire was June 2003 through December 2003 and the average exchange rate for that period was 563.94 CFA francs per US $. Finally, Ghana's exchange rate was established by obtaining the average rate from 2002 through 2003 which was 8305.03 cedis per US $.

In order to summarize the partial budget information, intervention strategies were divided into three categories based on the core management interventions that were focused on during planning meetings, these are: 1) vaccination against Newcastle disease virus 2) supplemental feeding and 3) improved housing. While these are broad categories and the exact management strategy is not the same in each country, they represent basic areas of focus within the current poultry farming system that received attention by researchers. Other intervention strategies were implemented along side the core three, but in order to simplify the overall information, they will not be considered in the economic analysis. Table II summarizes the core interventions made by each country and provides their profits and returns in US $. Egypt was not included in this table because their intervention and partial budget analysis focused on vaccination against infectious bursal disease virus (Gumboro Disease), not Newcastle disease vaccination.

TABLE II. SUMMARY OF THE CORE INTERVENTIONS.

Country		Profit (U.S.$)	Return (U.S.$)	Newcastle Disease Vacccination	Supplemental Feeding	Improved Housing
Cameroon	Ndop Zone	$0.18	$1.22	x		
Cameroon	Santa Zone	$10.00	$12.07	x		
Cote D'Ivoire	Group1	$33.46	$3.93	x		
Cote D'Ivoire	Group2	$637.48	$4.00	x	x	
Cote D'Ivoire	Group3	$62.66	$5.61	x	x	x
Ghana	Treatment	$403.83	$8.71		x	
Ghana	farmer given ND vac	$570.67	$155.88	x		
Kenya	control	$108.54	$1.85			
Kenya	1 Interv.	$59.87	$1.15		x	
Kenya	1 Interv.	$369.56	$3.36	x		
Kenya	2 Interv.	$178.92	$1.34	x	x	
Madagascar	Treatment 1	$18.33	$10.17	x		
Madagascar	Treatment 2	$33.06	$4.20	x	x	x
Mauritius	phase 1, zone 1	$51.90	$13.36	x		
Mauritius	phase 1, zone 2	$70.60	$17.81	x		
Mauritius	phase 2, zone2	$47.00	$1.60	x		x
Morocco	Intervention 1	$140.00	$2.40	x		
Morocco	Intervention 2	$471.00	$3.50	x	x	
Sudan	year 1	$642.00	$6.31	x		
Sudan	year 2	$1,610.00	$3.28	x		x
Sudan	year3	$2,190.00	$18.52	x		x
Tanzania	Intervention	$2,326.00	$3.49	x		
Uganda	montane region	$1,534.00	$2.81	x		
Uganda	agropastoral region	$1,093.00	$1.67	x		

DISCUSSION

Examination of the partial budgets revealed that single and multiple intervention strategies initiated in each country were all profitable and had a positive return on investment. Initial assessment of the programmes raises two key points. First of all, the research conducted in the initial portion of the study provided helpful information for determining which intervention strategies were needed and could be successfully implemented within the current system. Secondly, in this low input poultry system, focusing investment in the key area of disease control can produce significant economic benefits.

Information summarized in Table II clearly indicates that implementation of the Newcastle disease vaccination yields a positive return. No country found that vaccinating poultry against this virus was unprofitable. The next decision is whether the addition of a second or third core intervention is economically prudent. Feed tends to be a fairly high input intervention strategy and housing is a strategy with an initial investment that requires less input later. Tables III and IV have grouped intervention strategies by single intervention and multiple interventions and present their effect on profit and return. Profits from using a single intervention range from \$ 0.18 to \$ 2323.00 while the returns on investment have a narrower range from \$ 1.15 to \$ 17.81 with the mean being \$ 6.32. The mean return on investment when multiple interventions were implemented was \$ 5.26 and while this is also a positive return it is slightly less than a single intervention strategy and it required more investment and management. Six countries implemented multiple interventions as well as a single intervention including Newcastle vaccination only. Of these six countries, four found that vaccinating against Newcastle disease alone, yielded a higher return than adding other interventions with the vaccination. These results indicate the variability in outcome when housing and/or supplemental feeding is added. The variability in housing occurs because it depends on what structure is built (capital costs) and how costs are financed (cash or loan) and variability in supplemental feeding occurs because feed costs depend on which birds/chicks are supplemented and what the demand and supply of feed are in the market place.

TABLE III. PROFITS AND RETURNS FROM IMPLEMENTATION OF A SINGLE INTERVENTION.

Profits and Returns from Implementation of a Single Intervention						
		Profit (U.S.$)	Return (U.S.$)	Newcastle Disease Vacccination	Supplemental Feeding	Improved Housing
Cameroon	Ndop Zone	$0.18	$1.22	x		
Cameroon	Santa Zone	$10.00	$12.07	x		
Cote D'Ivoire	Group1	$33.46	$3.93	x		
Ghana	Treatment	$403.83	$8.71		x	
Kenya	1 interv	$59.87	$1.15		x	
Kenya	1 interv	$369.56	$3.36	x		
Madagascar	Treatment 1	$18.33	$10.17	x		
Mauritius	phase 1, zone 1	$51.90	$13.36	x		
Mauritius	phase 1, zone 2	$70.60	$17.81	x		
Morocco	Intervention 1	$140.00	$2.40	x		
Sudan	year 1	$642.00	$6.31	x		
Tanzania	intervention	$2,326.00	$3.49	x		
Uganda	montane region	$1,534.00	$2.81	x		
Uganda	agropastoral region	$1,093.00	$1.67	x		
	Range- min	$0.18	$1.15			
	Range- max	$2,326.00	$17.81			
	Average		$6.32			

TABLE IV. RETURNS FROM VARIOUS VACCINATION PROTOCOLS USED IN GHANA.

	Vaccine Comparisons		
Vaccine type	Heat stable NDI-2	Heat stable NDI-2	Heat stable NDI-2
Route administered	eye drop	feather brushing eye	feather brushing eye, farmer administered
Returns	14.79	11.08	**155.88**

TABLE V. PROFITS AND RETURNS FROM IMPLEMENTATION OF MULTIPLE INTERVENTIONS

Profits and Returns from Implementation of Muliple Interventions						
		Profit (U.S.$)	**Return (U.S.$)**	**Newcastle Disease Vacccination**	**Supplemental Feeding**	**Improved Housing**
Cote D'Ivoire	Group2	$637.48	$4.00	x	x	
Cote D'Ivoire	Group3	$62.66	$5.61	x	x	x
Kenya	2 interv	$178.92	$1.34	x	x	
Madagascar	Treatment 2	$33.06	$4.20	x	x	x
Mauritius	phase 2, zone2	$47.00	$1.60	x		x
Morocco	Intervention	$471.00	$3.50	x	x	
Sudan	year 2	$1,610.0	$3.28	x		x
Sudan	year3	$2,190.0	$18.52	x		x
	Range- min	$33.06	$1.34			
	Range- max	$2,190.00	$18.52			
	Average		$5.26			

Work conducted in Ghana also showed the significant increase in return that can be achieved by teaching farmers to administer their own Newcastle disease vaccinations. Tables IV and V. show returns from various vaccination protocols used in Ghana. A difference in return of $144.8 more is achieved by having farmers administer their own vaccinations. This level of return far exceeds anything seen with other interventions.

CONCLUSION

Data provided in this CRP report clearly indicates that vaccination against Newcastle disease is an economically viable recommendation for low input poultry production. The use of supplemental feed and improved housing as additional management changes can also be profitable, but these strategies do require more input and do not deliver the same consistent returns that vaccination produces. Because of the variability in local market conditions for feed and the availability of financing for housing, feed supplementation and housing should be considered for targeted intervention on a case-by-case basis. Newcastle disease vaccination is consistently profitable and effective, therefore vaccination is recommended for low input family poultry production in the countries participating in this project.

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TECHNICAL PARAMETERS FOR THE ASSESSMENT OF SCAVENGEABLE FEED RESOURCE FOR POULTRY

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Abstract

The scavengeable feed resource (SFR) comprises materials from two sources: household food waste and leftovers (HHL), and materials from the environment, i.e. crop by-products and the gleanings of gardens, fields and wastelands. This manual reviews and develops parameters and procedures for the estimation of SFR for birds that are on dedicated ranges without households or on homesteads. The aim is to determine the total amount of scavengeable material in any particular range (with or without households) in order to determine the "carrying capacity" of the range for poultry in different seasons and to estimate how much supplements will be required to meet the production target set for the flock size. The first parameter, the usage of the range, is assessed by visual inspection, space measurement and by automatic monitoring of birds by the use of telemetry. The second parameter is the intake of scavengeable materials (plants, insects and metazoans) from the range. The Pitfall trap method, Transect mapping and Quadrants are used to estimate the available feed materials while the actual intake of these materials is estimated by visual identification, physical separation and chemical analysis of the content of the crops of scavenging birds.

DEFINITION AND SCOPE OF SFR

All poultry systems that allow birds access to pasture, yard or range promote scavenging in some way. There is clearly a need to have more data on the available feed that can be scavenged from the free range, pasture and backyard as well as on how or what to supplement highly productive birds on the free range. The development of parameters for the assessment of the scavengeable feed resource can be of benefit to all poultry systems that involve some degree of scavenging. This manual presents the parameters and the procedures for the assessment of the amount of edible (feed) material for poultry that is available in a given rangeland, pasture or common land in a village. It is envisaged that this manual will be useful for researchers, technicians, development workers, trainers, technical institutions, students and farmers.

The concept of a scavengeable feed resource base (SFRB) was developed from field work done in Sri Lanka (Roberts and Gunaratne, 1992; Gunaratne *et al*, 1993). The SFRB comprises household waste, crop by-products and the gleanings of gardens, fields and wastelands if the homestead is the focus of scavenging. Without the confinement of the homestead, the SFRB can be defined as all the materials that are always or seasonally available in the environment and which the scavenging birds can use as feed (Sonaiya et. al., 2002a).

Having in view non-family poultry systems that utilize the range, the discussion of the parameters for scavengeable feed resource will include assessment of the range where there may be no households. For this reason, and to distinguish the scope from that within which SFRB was developed, the term Scavengeable Feed Resource (SFR) will be used in this manual.

SFR: origin and sources

The Scavengeable Feed Resource is made up of edible materials from the household and their surrounding environment such as food leftovers, by-products from harvesting and processing of grains, and cultivated and wild vegetation.

Household Food Wastes and Leftovers (HHL)

The scavengeable feed resource (SFR) includes the total amount of household food waste and leftover (HHL) that is thrown out and available to all scavenging animals in a given area. The size of the HHL depends on the number of households, the food crops grown and their processing methods as well as on the climatic conditions that determine the rate of decomposition of these food wastes. The HHL can be harvested by all scavenging animals (cattle, buffalo, sheep, donkey, goats, pigs, dogs, cats as well as wild, undomesticated animals) which all compete with poultry. The extent of the HHL that can be harvested depends on the species of poultry. A mixture of species of poultry is more effective in harvesting this resource than a single species can be.

Factors affecting quantity of HHL

Among the factors that determine the quantity of HHL are: climate, village housing density, crops grown, livestock owned, and religion or culture. Roberts (1999) reported that the size of the SFR varied with seasonal conditions and with activities such as cultivation and harvest. Kitalyi (1998) observed that available SFR depends on the agricultural production system prevailing in the village (which includes the cropping pattern, the animal production system) and the eating habits of the society.

Edible Materials from the Environment

The major scavengeable feed resources from the environment come from:

- household surroundings (gardens, crops and orchards, harvest residues) and
- uncultivated land, with such components as grass shoots, grass seeds, worms, insects, molluscs – snails, slugs, and stone grits and sand (Roberts and Senaratne, 1992; Sonaiya, 1995; Sonaiya *et al*, 2002a).

The portion of SFR that comes from the environment apart from the household varies with season and rainfall as well as with the life cycle of insects and other invertebrates. Tadelle (1996) reported that in Ethiopia, the SFR is deficient in protein during the dry season and in energy during the rainy season.

Generally, the supply of feed from scavengeable sources will be low from mid-dry season to mid-rain season, when there will be low insects and metazoan numbers, less green plant cover, low or no harvesting activities and so on. The reverse will be the case for between mid-rain to mid-dry seasons.

In summary, scavengeable feed resource (SFR) can be defined as all the materials that are always, or seasonally available in the environment and which scavenging chickens use as feed (Sonaiya *et al*, 2002a). The methods for determination of SFR developed by Roberts and Gunaratne (1992) were based mainly on the quantity of household leftovers only, thereby neglecting other contributions to the determination of SFR. But where there are no households, the environmental contribution will entirely determine SFR.

PARAMETERS AND PROCEDURES FOR THE ASSESSMENT OF SFR FOR POULTRY

Poultry scavenge around the household in farmsteads or village as well as on pastures, scrublands and forests around the village or farmstead. Their range, therefore, includes both households and open range.

Parameters for Direct estimation of SFR available

The aim is to determine the total amount of scavengeable feed in any particular range, determine the "carrying capacity" of the range for poultry and then be able to determine what and how much supplements are required to meet the production target set for the flock size.

Parameter 1 – HHL

The first attempts to directly assess SFR in Southeast Asia were based on the assumption that the household leftover (HHL) is the parameter, which makes the greater contribution to SFR than the materials from the environment. For example, Gunaratne *et al* (1993) reported a 72% contribution of HHL to SFR. Furthermore, various formulas for measuring, calculating or predicting SFR are HHL-based. Roberts (1992) in Sri Lanka, and Sonaiya *et al* (2002b) in Nigeria estimated an HHL-based SFR per flock and per bird unit, respectively. In the stepwise regression of SFR on some predictors, HHL contributed more to the accuracy of the prediction than any other parameter (Sonaiya *et al*, 2002b).

Parameter 2 – Range Usage

In the open range where there is no household and hence, no HHL, it is the materials from the environment that will entirely determine the contribution to the SFR. Under such a condition, an important parameter to measure is the usage of the given area of land by birds. Are there 'activity centres' where birds will gather? This can simply be assessed by visual inspection, space measurement and by automatic monitoring of birds. One way to monitor birds automatically is by the use of telemetry in which transmitters, receivers and data loggers are used to monitor the ranging activity of birds.

Parameter 3 – Range Biota Content

It is also important to assess the amount of scavengeable feed available from the open range apart from HHL. Quadrants can be used to determine the distribution of plants (grasses) per unit land area at a given time. Pitfall traps can be used to determine the number of insects and other metazoans available per unit area of land. Since changing climatic conditions (dry vs. rainy season) affect biota, it is necessary to determine their content in both seasons.

METHODS THAT HAVE BEEN USED FOR ASSESSING SFR

Roberts (1992) proposed two methods of determining the value of the SFR. One is based on household leftovers (HHL). The HHL method requires weighing the amount of household food leftovers generated by each family per day (H), the proportion of the crop content of scavenging birds (P) which is made up of H as determined by visual inspection. The ratio of H:P is then multiplied by the ratio of number of families in the community (n) to the number of families in the community with chickens (n–x).

Direct assessment of SFR on Farmsteads by the HHL method

Sonaiya *et al* (2002b) used the HHL method to estimate the SFR in four villages within the south-western rain forest ecozone of Nigeria, namely Ipetumodu 1 (P1), Ipetumodu 2 (P2), Moro (MR) and Yakooyo (YK).

The formula used for the assessment was that of Roberts (1992).

$$\text{SFR} = \frac{H}{P} * \frac{n}{n-x}$$

Where: *H* is the household leftover (kg dry weight)
P is the proportion of crop content, which is household leftover
n is the number of households in the settlement
x is the number of households in the settlement that are not keeping chickens

The factors H and P were obtained by measurements. The values for n and n–x were obtained from a census and (n/n–x) was treated as a ratio.

Determination of H, quantity of household leftover

Random samples of 3 cooperators in each of four villages (P1, P2, YK, MR) were selected for the collection of household leftovers. Plastic wastebaskets were supplied to these cooperators who were instructed to drop household kitchen leftovers in the baskets. Collection of household leftovers was done daily from week 1–4. Another group of twelve households were used for collection of household leftovers from week 5–8. Thus, a total of 24 households were used for collection of HHL in all the villages.

When the household leftovers were collected, they were put in plastic bags, labelled and taken in a cool box to the laboratory where they were dried in a Gallenkamp hot air oven to a constant weight in 72 hours.

The average household leftover (H, kg/family/day), was determined as follows:

$$\text{H} = \frac{\text{Total weight of household leftovers from a settlement}}{\text{Number of families from which they are collected}}$$

After drying to a constant weight, the household leftovers were ground, homogenized and samples were taken and stored in sample bottles, from which sub-samples were later taken for chemical analyses.

Determination of P, proportion of crop content in household leftovers

Forty-two tracer birds, 14 from P1, 8 each from YK and P2, and 12 from MR were used for the crop content examination. Determination of crop content was done at the end of week 4 of the study. The tracer birds were purchased from the flock owners, whether cooperators or not, who were willing to sell their birds. A total of 14 cocks, 20 growers and 8 hens were used as tracer birds.

The collection of tracer birds was done between 7.00 am and 7.00 pm in all the settlements. The tracer birds were killed immediately they were caught, eviscerated and the crop of each bird was removed, labelled and kept in the freezer overnight. The next morning the crops were opened up, the materials contained in them were visually identified and physically separated into two: material coming from the households and those coming from the environment. Fig. 1 shows some of the biological materials that are identified from the crops of the scavenging chickens.

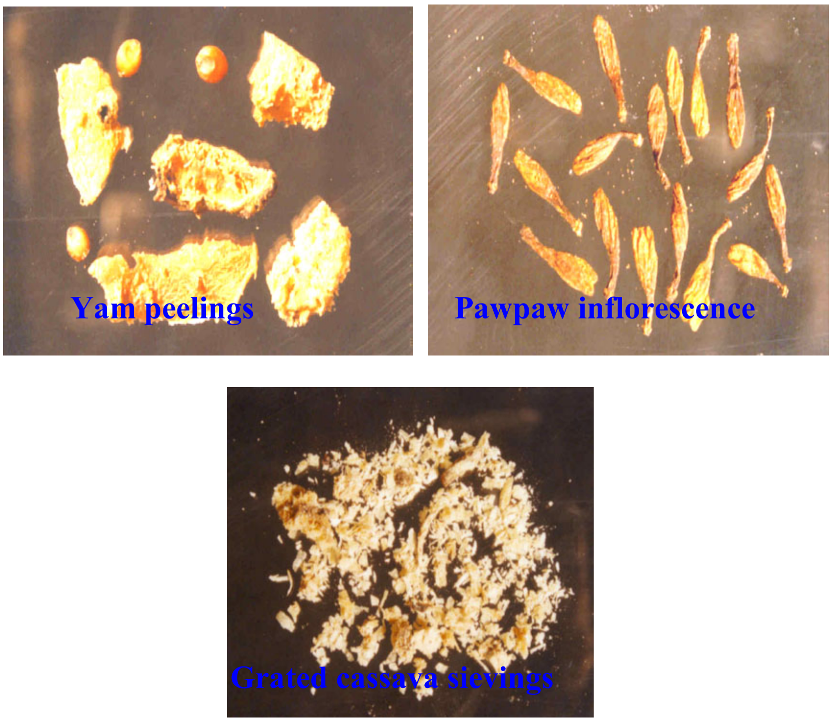

FIG. 1: Some feed materials in the crops of scavenging chickens in southwestern Nigeria (Photo O.A. Olukosi).

The crop contents, thus partitioned for each bird, were put in separate petri dishes and dried in hot air oven, for 72 hours until they attained a constant weight. The materials were then weighed, the crop content of all the tracer birds in each settlement were mixed and ground for subsequent chemical analyses.

P was determined for each tracer bird as follows:

$$P = \frac{\text{Dry weight of crop content identified as household leftovers, g}}{\text{Total dry weight of crop content, g}}$$

The average P for all the tracer birds in a settlement was determined for each of the settlements.

Chemical Analyses

Proximate analysis of the samples of the ingesta (crop contents) and samples of household leftovers was carried out. Birds were acclimatized to the range types for at least 2 days before they were sacrificed for crop content analysis. This is based on the fact that most of the marker from a marked meal can be recovered within 24 hours. Birds were caught from the range and sacrificed every 4 hours for a total of 12 hours per day for 14 days. According to Feltwell and Fox (1978) birds fill their crop in four hours cycles of eating, although some of the feed may completely bypass the crop on its way to the stomach, depending on the nutritional status of the bird and type of feed. Hence, it may be necessary to analyse the entire gastro intestinal tract and not just the crop within the 12-hour period between 06.30 and 18.30.

The digestive tracts of the sacrificed birds were opened, materials in the holding organs (proventriculus, crop and gizzard) were separated into individual petri-dishes and physically identified visually for seeds, insects, worms and plant materials. Visual and physical separation of the contents of holding organs enabled identification of the diet components. These were separated, weighed and the proportion of each class calculated. The separated components were dried to constant weight and chemically analysed for proximate fractions by the method of AOAC (1994). Gross energy was determined using Gallenkamp ballistic bomb calorimeter (Model CB – 370) and from gross energy values the metabolizable energy content was calculated (by using the method of Larbier and Leclerq, 1992). All analyses were done in duplicates.

Statistical design and analysis

The statistical design of the study was the randomised complete block design. Each of the settlements was a block while the cooperators' flocks were the replicates. The data on flock characteristics of the study settlements was subjected to descriptive analysis using the mean, percentages and ranges.

Data collected on performance and reproductive parameters were subjected to a two-way analysis of variance using the general linear model procedure of SAS. Significantly different means were separated using the Duncan's multiple range test.

Results of Direct Assessment of SFR on Farmsteads

TABLE I. QUANTITIES OF HOUSEHOLD LEFTOVERS IN VILLAGES.

Villages	Household leftovers, g/day	
	Dry weight	Wet weight
Moro	50	54
Yakooyo	175	187
Ipetumodu 1	117	125
Ipetumodu 2	108	116
Average	112	121

Source: Olukosi (2002)

TABLE II. NUTRITIVE VALUE OF MATERIALS IN THE CROP AND IN THE HOUSEHOLD LEFTOVERS.

Proximate fractions	Crop content	Household leftovers
Dry matter, %	97.7	92.9
Organic matter, %	77.2	92.1
Ash, %	22.8	8.2
Crude fibre, %	7.8	13.6
Ether Extract, %	9.5	15.9
Crude protein, %	8.7	8.8
NFE, %	49.1	59.1
Metabolizable Energy (determined), kcal/kg	2767	3646

Source: Olukosi (2002)

TABLE III. THE AVERAGE DAILY SFR.

Village	SFR, g/flock/day Wet weight	Dry weight	SFR, kg/year Dry weight
Moro	132	121	43
Yakooyo	430	427	153
Ipetumodu 1	368	360	131
Ipetumodu 2	359	352	127
Average	363	315	114

Source: Olukosi (2002)

TABLE IV. AMOUNT OF SFR IN FOUR VILLAGES IN SW-NIGERIA.

Villages	Scavengeable feed resource, g/bird/d	Metabolizable energy, kcal/bird/day	Crude protein, g/bird/day
Moro	6.9	20.75	0.48
Yakooyo	23.7	54.91	2.04
Ipetumodu I	22.5	63.86	2.41
Ipetumodu II	26.9	76.34	2.31
Average	19.7	53.97	1.81

Source: Sonaiya *et al*., 2002b

Discussion of Direct Assessment of SFR on Farmsteads

The average daily HHL in southwest Nigeria was 121 g/day (Table I), it was made up of cooked rice, weevil-infested cowpea, pepper, onion, yam peelings and sundries (bread, vegetable twigs, yam flour dough (*amala*)). The HHL made up 64% of the crop content. The other materials in the crop were insects and metazoan, grass blades, and grits (in the descending order of abundance). The HHL had 92.1% organic matter, 15.7% oil and 8.8% crude protein (Table II). The higher value of ash in the crop content is as a result of grits which the chicken swallow and act as diluents for the HHL in the crop.

The average quantity of SFR was 363g/flock/day and 115.1kg/flock/year (Table III). This translates into an SFR of 19.7g/bird/day providing 53.97 kcal ME/bird/day and 1.81g crude protein/bird/day (Table IV). The study was carried out in the dry season (November–January), this is not harvest season in Nigeria.

In a study amongst thirty-four families in Sri Lankan villages (Gunaratne *et al*., 1993), 24-hour collection of (HHL) was made on 14 occasions. The collections were weighed, identified visually and analyzed for proximate composition, calcium and phosphorus. Fifteen hens were collected late in the morning while scavenging, slaughtered and their crop and gizzard content collected, identified visually, weighed and chemically analysed (Table V).

TABLE V. MAJOR FEED COMPONENTS IN THE CROP CONTENT OF SCAVENGING HENS.

Component	DM Percent	CP	EE	CF	Ash	Ca mg/g	P
Household waste	43.2	10.3	7.2	2.2	1.4	0.8	4.0
Coconut residue	24.1	6.9	38.1	8.9	1.1	1.1	6.0
Broken rice	89.9	9.0	1.3	1.5	3.2	0.5	1.4
Crop content	34.4	9.4	9.2	5.4	16.0	0.8	0.9

Source: Gunaratne *et al.*, 1993

The average daily HHL was 460±210 g drained, wet weight. The HHL was made up of 26% cooked rice, 30% coconut residue, 8% broken rice and 36% sundries (vegetable trimmings, egg shells, bread, dried fish and scraps). HHL comprised 72% of the crop content of the 15 hens that were slaughtered. The balance of the crop content came from the environment and consisted of 13% grass shoots, 8% small metazoans (earthworms, snails, ants and flies) and 7% paddy rice.

The SFR determined by the HHL method in south-east Asia (Table VI) contained 300–600 g dry matter, 8–10% of vegetable protein and 2,100–2,500 kcal ME/kg (Prawirokusumo, 1988; Gunaratne *et al*, 1993). The amount of protein and metabolizable energy (ME) in the SFR was determined from an analysis of the crop content. In Sri Lanka, the annual SFR available to each family was calculated to contain 23kg of protein and 468 Mcal ME (Gunaratne *et al*., 1993).

TABLE VI. SFR VALUES OF AVERAGE FAMILY FLOCK IN SOUTH-EAST ASIA.

Country	SFR, kg DM/year	Source
Indonesia	475	Kingston and Creswell, 1982
Thailand	390	Janviriyasopak *et al*., 1989
Sri Lanka	195	Gunaratne *et al*., 1993
Sri Lanka	197	Gunaratne *et al*., 1993

Direct assessment of SFR on Free Range

On free range, the feed resources come from the environment; the first procedure in the assessment of SFR is to assess the use of the range by the birds. Poultry cover accessible area of the range in search of feed. To determine SFR on the range requires using two groups of methods. The first group is to estimate probable feed materials available on the range and includes the pitfall trap and the Transect mapping and Quadrant. The second group is to evaluate the actual content of the crop of the birds after scavenging and includes visual and physical separation of the crop content as well as chemical analysis.

Pitfall trap method

This is used for the measurement of the quantity of insects and other metazoans which are trapped, identified and classified. The amount and type of the crawling insects and metazoans can be determined by the pitfall trap method of Obeng-Ofori (1994) as modified by Olukosi (2002). An area $1m^2$ is used for each estimation. Five bottle jars, each 6 cm in diameter both at the top and bottom, 13 cm in height and 0.2 cm rim thickness are buried to the level of 1 cm below the soil, with the soil gently sloping into the bottle (Fig. 2). The five bottles in the $1m^2$ area are arranged diagonally with approximately 30 cm space between them (Fig. 3). Fig. 4 shows the bottle jars used as traps in Olukosi (2002) study.

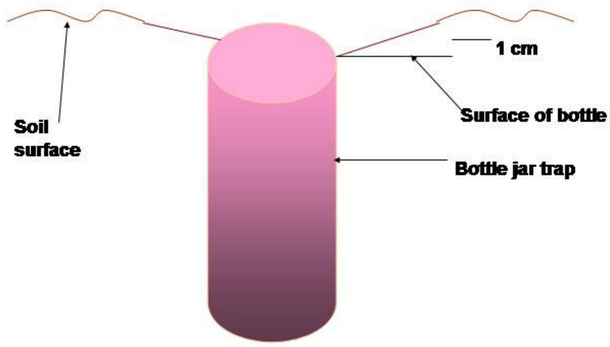

FIG. 2: The placement of the bottle on the ground.

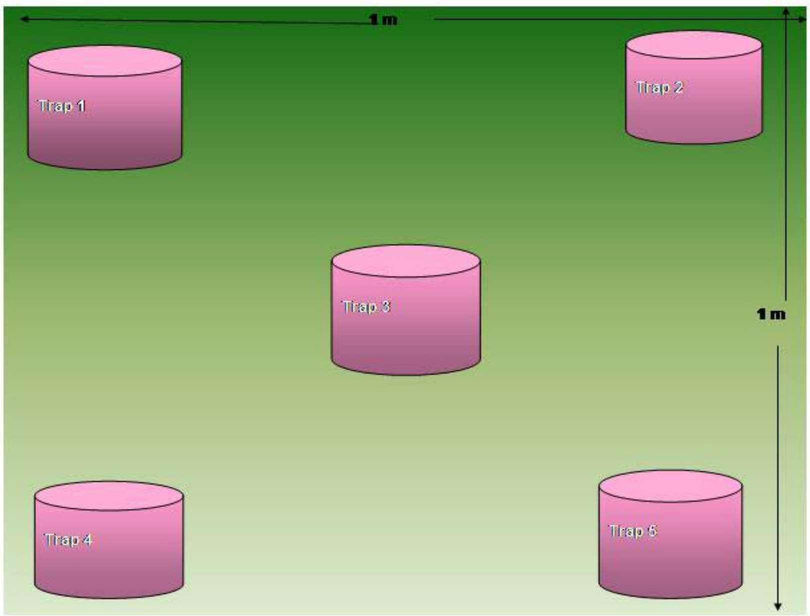

FIG. 3. Layout of bottle jar traps on 1-m^2 of ground

FIG. 4. The pitfall trap jars used in the study (Photo: O.A. Olukosi)

The bottle traps are filled to 1/4 capacity with 4% formaldehyde solution, and left in place for 24 hours. After the 24 hours, the traps are removed, and the insects and other metazoans caught are identified and counted. Ten random trap samplings should be taken from each of the pits. The species trapped are identified and classified by their orders using the NRI (1996) chart, and then counted. The total collection of the species in the different orders are oven-dried and weighed to determine the quantity of insects and metazoans trapped per m^2 of range in 24 hours.

Transect mapping and Quadrants of the vegetation cover

This can be done using the method of Kirsopp-Reed (1994) as modified by Olukosi (2002). A transect map can be drawn following walks across the range during which vegetation cover and the slope of the land are recorded. Quadrants of $1m^2$ are used to facilitate the determination of number of plant stands per square meter (Fig. 5). Ten random throwings of quadrants should be made at different vegetation zones in the range to allow estimation of plant components. The number of anthills (if present) in each range should be counted in the process of transect mapping. The total number of anthills is counted for each range or for a measured area of the range. Quantification should be per square meter of land area and replicated at least thrice for each range area and for a total of 12 days in each season of the year.

In Olukosi (2002) study, transect mapping was based on walks across the villages during which vegetation cover and the slope of the land were recorded. Quadrants of $1m^2$ were used to facilitate the determination of number of plant stands per square meter (Fig. 5). Ten random throwings of quadrants were done at different vegetation zones within each village to allow estimation of plant components. The total number of refuse heaps were counted for each of the settlements. In the case of P1 and P2, the determination of the refuse heaps was done by counting the number of refuse heaps in a measured area of the settlement, and then the total number of refuse heaps for the entire settlement was estimated.

FIG. 5. The Quadrant Used in the study and its placement on the ground (Photo: O.A. Olukosi)

Statistical Analysis and Design

All data from different range types should be analysed by ANOVA to test the effects of season, range type, species and breed and the significantly different means compared using Duncan's multiple range test.

For simplicity, we will consider a three-factor design. The factors are:

- Range types (three range types: shrub, grass and the mix)
- Breed types (two types: local and exotic)
- Species (three species: chicken, ducks and guinea fowl)

This is a 2 × 3 × 3 factorial design. There are three main effects namely the effects of the breed type, the range type and the species. There are also three 2-factor interactions, i.e. the breed × range type, breed × species and species × range type interactions, and finally one 3-factor interaction, the breed × range type × species interactions.

Body weight is assumed to be a good measure of the response to SFR. The following dummy Figures for the daily body weight gain (g) of birds subjected to the factors enumerated above are analysed as an example.

TABLE VII. DAILY BODY WEIGHT GAIN OF BIRDS ON DIFFERENT RANGE TYPES.

Breed	Species	Range type	Replicates 1	2	3	Treatment total
Local	Chicken	Shrub	1.11	1.35	1.04	3.50 (*a*)
		Grass	1.36	1.58	2.60	5.54 (*b*)
		Mixture	1.05	1.60	1.92	4.57(*c*)
	Duck	Shrub	3.05	3.65	2.92	9.62 (*d*)
		Grass	3.46	4.06	4.76	12.28 (*e*)
		Mixture	2.50	2.48	2.36	7.34 (*f*)
	Guinea Fowl	Shrub	1.56	1.76	1.60	4.92 (*g*)
		Grass	1.68	1.34	1.78	4.80 (*h*)
		Mixture	4.08	3.67	4.12	11.87 (*i*)
Exotic	Chicken	Shrub	5.81	5.48	5.39	16.68 (*j*)
		Grass	4.84	5.95	5.01	15.80 (*k*)
		Mixture	3.58	2.95	1.06	7.59 (*l*)
	Duck	Shrub	2.67	2.56	3.05	8.28 (*m*)
		Grass	4.67	5.05	4.99	14.71 (*n*)
		Mixture	3.46	2.38	3.04	8.88 (*o*)
	Guinea Fowl	Shrub	1.12	2.13	4.05	7.30 (*p*)
		Grass	2.59	3.48	4.15	10.22 (*q*)
		Mixture	3.13	4.51	3.56	11.20 (*r*)
Replicate total			51.72	55.98	57.40	GT = 165.10

a,b,c… These are used to simplify the calculations for ANOVA

ANOVA

Correction Factor (CF) = $(165.10)^2 / 54 = 504.78$
Total sum of squares (SS) = $(1.11^2 + 1.35^2 + \ldots + 4.51^2 + 3.56^2) - CF = 103.54$
Treatment SS = $(a^2 + b^2 + \ldots + r^2)/3 - CF = 89.10$
Replicates SS = $(51.72^2 + 55.98^2 + 57.40^2) / 18 - CF = 0.97$
Error SS = 103.54 – 89.10 – 0.97 = 13.47

TABLE VII (I) ANOVA FOR SPECIES × RANGE TYPE.

Species	Shrub	Grass	Mixture	Row total
Chicken	*a+j*	*b+k*	*c+l*	53.68
Duck	*d+m*	*e+n*	*f+o*	61.11
Guinea Fowl	*g+p*	*h+q*	*i+r*	50.31
Column total	50.3	63.35	51.45	

Summary for the table of Species × Range type ANOVA
Total SS = $(20.18^2 + 21.34^2 + \ldots + 23.07^2) / 6 - CF = 33.49$
Range type SS = $(50.3^2 + 63.35^2 + 51.45^2) / 18 - CF = 5.80$
Species SS = (53.682 + 61.112 + 50.312) / 18 – CF = 3.45
Range × Species SS = 33.49 – 5.80 – 3.45 = 24.24

TABLE VII (II) ANOVA FOR SPECIES × BREED.

Breed	Species Chicken	Duck	Guinea fowl	Breed total
Local	*a+b+c*	*d+e+f*	*g+h+i*	64.44
Exotic	*j+k+l*	*m+n+o*	*p+q+r*	100.67
Species total	53.69	61.11	50.31	

Summary for the table of Species × Breed ANOVA
Total SS = $(13.61^2 + 29.24^2 + \ldots + 28.72^2) / 9$ – CF = 45.78
Breed SS = $(64.44^2 + 100.67^2) / 27$ – CF = 24.37
Species SS = 3.45
Breed × Species SS = 45.78 – 24.37 –3.45 = 17.96

TABLE VII (III) ANOVA FOR BREED × RANGE TYPE.

Breed	Range type Shrub	Grass	Mixture	Breed total
Local	*a+d+g*	*b+e+h*	*c+f+l*	64.44
Exotic	*j+m+p*	*k+n+q*	*l+o+r*	100.66
Range total	50.30	63.35	51.45	

Summary for the table of Species × Breed ANOVA
Total SS = $(18.04^2 + 2.62^2 + \ldots + 27.67^2)/9$ – CF = 36.10
Breed × Range SS = 36.10 – 24.37 – 5.80 = 5.93

The following summary is for the three-factor interaction ANOVA
Breed × Range × Species SS =
Treatment SS – Breed SS – Range SS – Species SS – Breed × Species SS – Range × Species SS – Breed × Range SS, i.e.
Breed × Range × Species SS = 89.10 – 24.39 – 3.45 – 5.8 – 17.96 – 24.24 – 5.93 = **7.33**

TABLE VIII. SUMMARY ANOVA FOR THE HYPOTHETICAL STUDY.

Source of variation	Degrees of freedom	SS	Mean Square (MS)	F ratio	Remark
Total	53	103.54	–	–	
Replicates	2	0.97	–	–	
Breed	1	24.39	24.39	60.98	NS
Species	2	3.45	1.725	4.313	NS
Range	2	5.80	2.90	7.25	NS
Breed × Species	2	17.96	8.98	22.45	NS
Range × Species	4	24.24	6.06	15.15	NS
Breed × Range	2	5.93	2.965	7.41	*
Breed ×Range × Species	4	7.33	1.833	4.58	NS
Error	34	13.47	0.40	–	

NS – Not significant ($p>0.05$)
* – significant ($p\leq0.05$)

Only the Breed × Range interaction was significant ($p\leq0.05$) in this hypothetical study.

RESULTS

Olukosi (2002) used pitfall traps to identify and quantify the insects and metazoans available to scavenging chickens on free range in four villages in southwestern Nigeria (Table IX). The insects trapped in the pitfall jar traps belonged to the orders hymenoptera, orthoptera, diptera, isoptera and coleoptera, while the metazoans trapped include earthworm and molluscs (Fig. 6).

TABLE IX. NUMBER AND PROPORTIONS OF INSECTS AND METAZOANS TRAPPED IN THE SOUTHWESTERN NIGERIA.

Village	Total number (/m^2/day)	% insects	% metazoans
Moro	52	91.83	8.17
Yakooyo	68	96.34	3.66
Ipetumodu1	37	97.62	2.38
Ipetumodu2	63	96.41	3.59
	55±14	95.55	4.45

Source: Olukosi, 2002

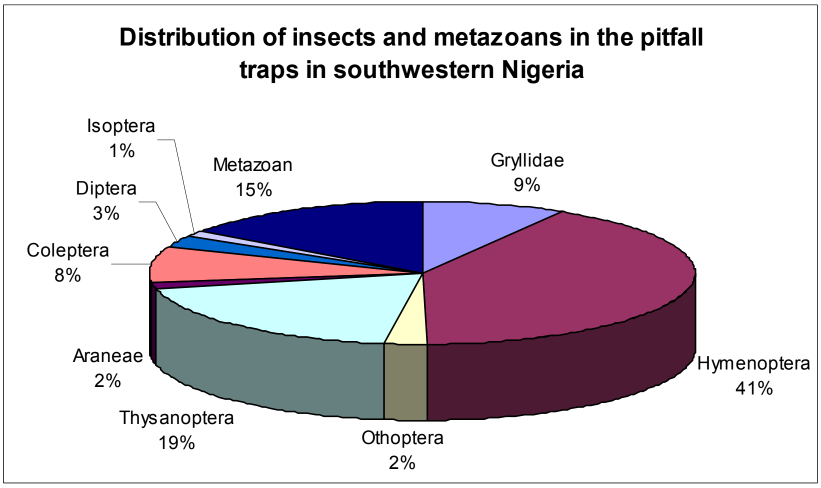

FIG. 6. Distribution of fauna in a pitfall trap arena in southwestern Nigeria (Source: Olukosi (2002)

DISCUSSION

Tadelle (1996) assumed the main components of the SFR to be insects, worms, seeds, plant materials etc with very small amounts of grain and HHL. The amount and availability per bird of this SFR are significantly dependent on season, grain availability in the household, time of grain sowing and harvest, and the biomass of the village flock.

TABLE X. EFFECT OF SEASON ON PHYSICAL COMPONENTS OF THE CROP OF SCAVENGING LOCAL HENS IN THE CENTRAL HIGHLANDS OF ETHIOPIA.

	Physical components (% fresh basis)				
Season	Seeds	Plants	Worms	Insects	Others
Short rain	37.5	22.5	2.6	14.6	22.7
Rain	25.8	31.8	11.2	7.7	23.4
Dry	29.5	27.7	6.2	11.1	25.6
Mean	30.9	23.3	6.7	11.1	23.9

Season	Physical components (% fresh basis) Seeds	Plants	Worms	Insects	Others
S.E.	7.9	6.0	4.5	4.5	4.6
Altitude					
High	33.2	28.2	9.0	8.8	20.8
Medium	32.0	27.9	5.9	11.5	22.7
Low	27.7	25.8	5.1	13.1	28.3
Mean	31.0	27.4	6.8	11.2	23.6
S.E.	3.6	0.8	2.2	2.3	3.4

Source: Tadelle, 1996

TABLE XI EFFECT OF SEASON AND ALTITUDE ON CHEMICAL COMPOSITION OF CROP CONTENT OF SCAVENGING CHICKENS IN CENTRAL HIGHLANDS OF ETHIOPIA.

	Season				Altitude				
	Short rain	Rain	Dry	SE	High	Medium	Low	Mean	Range
DM, %	54.1^{a}	39.7^{b}	61.0	0.013	43.8	50.9	58.6	50.7	26.4–85.8
CP, %	8.7^{ab}	10.2^{b}	7.6^{a}	0.021	9.8	8.8	7.9	8.8	4.3–15.4
CF, %	10.3^{a}	9.9^{b}	10.5^{c}	0.014	9.6	10.2	11.0	10.2	6.5–14.0
EE, %	2.3^{a}	1.7^{b}	1.2^{c}	0.039	1.97	1.62	1.52	1.9	0.3–4.7
Ash, %	5.5^{a}	10.8^{b}	8.1^{c}	0.022	9.4	7.5	6.8	7.8	1.6–15.7
Ca, %	0.7^{a}	1.1^{b}	0.8^{a}	0.035	0.91	0.95	0.71	0.9	0.2–1.9
P, %	0.5^{a}	0.7^{b}	0.7^{b}	0.031	0.48	0.74	0.63	0.6	0.1–2.4
Calculated ME, kcal/kg	3128^{a}	2713^{d}	2751	14.87	2880^{b}	2897^{b}	2816^{c}	2864	2245–3528

^{abc} – means in the same row with different superscripts are significantly different ($p \leq 0.05$)
Source: Tadelle, 1996

INDIRECT METHODS OF ASSESSING THE SFR

The MPE method

Given the difficulty of determining the amount of HHL and the biota per unit area to which each flock has access to scavenge, the direct method of assessing SFR is cumbersome, time consuming and inaccurate. The MPE method only requires the calculation of the amount of energy required to support the maintenance and production of the chickens in the flock. That means that if there is scavengeable feed available, the actual amount of the scavengeable feed consumed by the birds is related to their energy requirement for maintenance, growth and egg laying. In the absence of any other source of feed, the daily consumption of the flock is the SFR.

The SFR (kg/family flock/year) derived from calculations based on live performance of the birds is obtained using Roberts (1992) formula:

$$SFRB = \frac{\sum E_j}{E_s}$$

where: SFRB = Scavengeable feed resource base (kg/family flock/year)
j = average flock size
E = the ME requirement for the daily maintenance and production of each bird (kcal/bird)
E_s = the ME in the scavenged feed (kcal/kg dry weight).

The E_j is calculated from the data on performance and productivity of scavenging chickens obtained over a period of eight weeks using the formula of NRC (1994):

$$E = W^{0.75}(173 - 1.95T) + 5.5\Delta W + 2.07EE$$

where: E = E_j defined above
W = average body weight (kg)
T = ambient temperature (°C)
ΔW = body weight gain (g/bird/day)
EE = daily egg mass (g).

The E_s (kcal/kg) is calculated from the gross energy (GE, kcal/kg) value of the crop content. The ME value is calculated from the GE value using, for example, the formula of Carrel *et al* (1989):

$$ME = 6.913GE - 18.5CP - 109.5CF$$

where: ME = metabolizable energy (kcal/kg)
GE = gross energy (kcal/kg)
CP = % crude protein
CF = % crude fibre.

Sonaiya *et al* (2002b) determined the SFR using the calculations based on the formula of Roberts (1992) as follows:

$$SFR = \sum E_j/E_s$$

Where: j is the average number of birds in the family flock
E is the ME requirement for the daily maintenance and production of each bird per day, kcal/kg dry matter.
Es is the ME in the scavenging feed, kcal/kg dry weight
j was determined from a census of family flock, using the questionnaires
Es was estimated from crop content
E was calculated for each bird from the data of growth rate and egg production collected weekly from the cooperators' flocks.

The formula of National Research Council (1984) was used in estimating the ME/bird/day as follows:

$$ME/bird/day = W^{0.75}(173 - 1.95T) + 5.5\Delta W + 2.07EE$$

where: W is the average body weight, kg
T is the ambient temperature, 26^0C was assumed throughout
ΔW is the change in body weight, g/day
EE is the daily egg mass, g/day

From the census of the family flock, the average number of birds in each class (i.e. cocks, hens, growers, and chicks) was determined. The daily egg mass (96 kcal for a large egg, 36 kcal for a small egg) was not included in the determination of ME requirement of all classes of birds, except hens. The ME requirement calculated for each bird (E) was then multiplied by the average number of birds (j) in the particular class to determine E_J and the summation of all the ME requirement for all the classes of birds was used in estimating $\sum Ej$ (Table XII).

TABLE XII. DETERMINATION OF ΣEJ (KCAL ME/KG) FOR SCAVENGING CHICKENS IN THE VILLAGES.

Village	Category of bird	W (kg)	ΔW (b/bird/day)	EE (g)	E (kcal/bird)j		Ej (kcal/day)
Moro	Cocks	0.941	3.36	–	135.3	2.8	378.9
	Hens	0.806	0.8	6.90	122.7	3.4	417.7
	Growers	0.701	6.0	–	126.7	5.3	671.5
	Chicks	0.040	0.8	–	15.3	6.3	96.39
ΣE_j							1564
Yakooyo							
	Cocks	1.001	3.6	–	142.2	2.7	383.9
	Hens	0.813	0.9	12.6	135.8	3.6	488.9
	Growers	0.641	6.4	–	122.8	4.9	601.7
	Chicks	0.075	2.2	–	29.6	6.4	189.4
ΣE_j							1664
Ipetu 1	Cocks	0.966	2.4	–	132.4	1.7	225.1
	Hens	0.889	1.2	9.02	137.3	3.4	466.8
	Growers	0.621	5.4	–	115.3	4.3	495.8
	Chicks	0.087	3.3	–	37.7	6.9	260.1
ΣE_j							1448
Ipetu 2	Cocks	1.034	2.9	–	141.4	1.4	198.0
	Hens	0.831	2.2	12.73	144.9	2.8	405.7
	Growers	0.642	7.9	–	131.2	4.4	577.2
	Chicks	0.136	3.8	–	48.3	5.0	241.5
ΣE_j							1422

Source: Olukosi (2002)

TABLE XIII. AMOUNT OF SCAVENGEABLE FEED RESOURCE IN FOUR VILLAGES IN SOUTHWESTERN NIGERIA.

Village	SFR g/flock/day	kg/year
Moro	520	190
Yakooyo	718	262
Ipetumodu 1	510	186
Ipetumodu 2	395	144
Average	535±134	196±49

Source: Olukosi (2002)

In the study of Gunaratne *et al* (1993), during which each family flock had access to the waste from 2 households, the hen day egg production for all hens was 30% (with a range of 11–57) and did not vary significantly during the 12 months of the study. Chick body weight at 20 d ranged from 41 to 100g, at 70 d from 142 to 492. Mortality rate was 65% within 70 days. Losses were attributed mainly to predators, particularly dogs, cats, mongooses, crows and raptors. More than 90% of the hen's day was spent scavenging over a radius of 110–175 m. The stalls of cattle and goats were favourite scavenging areas.

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GLOSSARY OF TERMS

AOAC – Association of Official Analytical Chemists

Aviary – A type of housing used for birds which provides an enclosure that gives a level of natural, wild environment for the birds. There are provision for perches and nests for the birds' comfort.

Cafeteria type feeding – The kind of feeding of chickens that allows them to select and balance their own feed intake. This is achieved by providing different feed materials that supplies different nutrients in separate containers and allowing the chickens to select freely from the containers.

Fauna – The types of living organisms apart from plants found in an area

HHL – Household leftovers. This defines the quantity of kitchen leftovers that each family has at the end of a 24-hour period.

IFOAM – International Federation of Organic Agriculture Movement

Ingesta – This represents the feed materials in the gastro intestinal tract of an animal

MPE – Maintenance and Production Energy

Niche market – A specialized market for a product

NRC – National Research Council

Pitfall trap – This is a standard entomological method of sampling the types and probable number of insects in a given area. It makes use of jars immersed to just below the ground level as traps for mainly crawling insects.

Voluntary Feed Intake – This is the quantity of feed that a chicken consumes by itself without being forced.

DISEASE CONTROL STRATEGIES IN THE SMALLHOLDER LIVESTOCK DEVELOPMENT PROJECT IN FIVE SOUTHERN DISTRICTS OF BANGLADESH

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Abstract

The disease control strategies of the project are centered around the 'poultry worker' or vaccinator who receives training and a vaccination kit, and earns income from her vaccinations. Vaccinations for chickens are given against three key diseases: infectious bursal disease, Newcastle disease and fowl pox, and ducks are vaccinated against duck plague. It has been necessary to adapt the vaccination programme several times, particularly to control infectious bursal disease. The farmers receive the support of government veterinarians and livestock officers in the diagnosis of diseases. Normal bio security measures are applied to the small parent farms supplying hatching eggs and to the chick rearing units. Vertically transmitted diseases are controlled through monitoring of grandparent stock. A programme of parallel research undertaken by national institutions provides information to support the adaptation of disease control strategies. The practical application of these strategies is discussed, and the importance of them in a project providing credit for family poultry production is emphasised.

INTRODUCTION

The constant threat of disease makes poultry rearing an inherently risky business. Therefore it could be questioned why, in a credit programme for poor people, smallholder poultry production is promoted as an enterprise. The answer is that it can only be promoted if a comprehensive disease control programme is in place. While most of the other papers in these proceedings report the results of research on family poultry production, this paper reports the practical strategies that have been developed and are in use in a relatively large scale family poultry project.

The Smallholder Livestock Development Project in Five Southern Districts targets more than 100,000 people in its area of operation. Ninety five percent of these are known as 'key rearers' and operate an enterprise in two parts: firstly they keep five semi-scavenging hybrid laying hens, and secondly they use four large indigenous broody hens to hatch exotic fertile eggs. The chicks from these eggs are raised under a protected environment using creep feeding, and are then sold for meat, or used to replace the laying hens. The hatching eggs are supplied from an enterprise known as 'model breeder' which is a small scale parent farm comprising a total of 60 of the two parent birds required to produce the hybrid. An alternative source of the hybrid hens is from an enterprise known as 'chick rearer' which raises 300 day old hybrid chicks produced by government poultry farms. A similar system is in operation using ducks, except that a pure breed is used. These are the enterprises involving live birds which have to be protected from disease.

STRATEGIES

Vaccinators

The core of the disease control strategy is the 'poultry worker,' a vaccinator who is herself recruited from the same community as the key rerears. There is one poultry worker for every 40 key rearers. She is supplied with a vaccination kit, comprising a thermos flask to keep the vaccines cool during transportation, dropper bottles for eye drop vaccination, an automatic syringe with needles for injectable vaccines, a bifurcated needle for wing web vaccination, a measuring cylinder and bottles for dilution of vaccine, and a carrying box. She is also supplied with a distinctive yellow umbrella bearing the extension slogans of the project which can be roughly translated as 'give vaccine, get money' and 'give feed, get profit.' She receives ten days practical training under the supervision of an area manager who is a veterinary or animal husbandry graduate. The area manager himself, as well as the extension workers whom he supervises are given a centralised training of trainers course. The poultry worker makes an income from making a small charge for each vaccination, which can also be paid for in kind, such as with eggs. Her business need not be limited to farmers involved in the project; indeed it is to their advantage that other farmers' poultry surrounding their enterprises be vaccinated.

Vaccination programme

Unlike programmes designed for intensive poultry production, vaccination for chickens is given against only three key diseases: Newcastle disease, infectious bursal disease, and fowl pox. The detailed vaccination programme currently recommended in use for chickens is given in Table I.

TABLE I. CHICKEN VACCINATION PROGRAMME.

Age	Disease	Vaccine	Route of inoculation
1 day	Infectious bursal disease	Bursaplex	Subcutaneous injection
1–7 days	Newcastle disease	Baby chick Ranikhet vaccine (lentogenic)	Eye drop
3–7 days	Fowl pox	Pigeon pox	Wing web
10–12 days	Infectious bursal disease	228E (intermediate)	Eye drop
1 month	Fowl pox	Fowl pox	Wing web
2 months	Newcastle disease	Ranikhet disease vaccine (mesogenic)	Intramuscular injection

Ducks are given only duck plague vaccine, at about 2 weeks of age, as a 1ml injection in the breast muscle, with a booster dose about 2 weeks later.

Veterinary support

Each administrative sub-district or 'upazila' is provided with an 'upazila livestock development centre' where a local government livestock officer and veterinary surgeon are based. In case of disease they can be consulted for a diagnosis. Motorcycles for their transport are provided by the project.

Bio security

Not all of the sort of bio security measures practised in industrial poultry farms are applicable to these small family enterprises. However, model breeders and chick rearers do have to go through the normal procedures of cleaning and disinfecting their chickens houses after each lot, and leaving them empty for 3 weeks. Moreover, disinfectant foot dips are used and entry to the chicken house is limited to the person actually tending the birds. Care is taken to quarantine new birds for at least 7 days, and to dispose of birds that have died through disease by burying them.

Vertically transmitted diseases

In addition to the 3 viral diseases mentioned above, the birds are at risk from vertically transmitted diseases, particularly salmonellosis and mycoplasmosis. The risk comes from the government farms from which the parent stock is supplied to the model breeders. The strategy here is to avoid supplying birds from contaminated farms and to maintain grandparent stock under higher bio security conditions, including restricted access and special clothing for workers. The grandparent stock is regularly tested for Salmonellosis and Mycoplasmosis.

Research

Finally, an important part of the disease control strategy is parallel ongoing research. The project supports both applied research contracts with national institutions, and research fellowships for Masters students. The latter provide a very flexible framework through which small applied research projects can be carried out. Examples of ongoing research projects pertaining to disease control are one on the causes of mortality in the chicks raised by broody hens, and one on the epidemiology of bacterial diseases in the small parent farms. The results of these research programmes can be used to adapt disease control strategies.

DISCUSSION

The previous section describes the strategies that have been adopted to control disease; now the extent to which they have been successful, and the extent to which they have been adapted will be discussed.

Although a cost benefit analysis can easily show that the investment in vaccination is cost effective, this is not always evident to the poultry worker’s customers, and in some but not all areas they have had initial difficulties in starting the business going. A general leaflet is being prepared outlining the advantages of vaccination for distribution through ‘resource learning centres’ along with extension material for other types of farming, and this should have a positive impact on the vaccination business.

The vaccination programme presented above has been adapted several times since the beginning of the project. Initially for Newcastle disease imported heat resistant V4 vaccine and inactivated vaccine was promoted. However there was a difficulty in getting people to accept these because, although they were cost effective, they were undercut in price by the Newcastle vaccines produced by the government. This is in turn led to a problem of shortage of vaccine because of the erratic production and distribution of the government vaccines, highlighting the danger of the government subsidies for vaccines. The problem has now been more or less overcome, at least for Newcastle disease, by the supply of vaccines from a local private manufacturing company. Although vaccines from different sources have been used, there has been essentially no problem in controlling Newcastle disease; very few cases have arisen. This has not unfortunately been the case for infectious bursal disease, whose control has been much more difficult, no doubt in part due to the serological variation which the virus undergoes. The first vaccination programme suggested was vaccination of chicks at about one week of age with a mild strain of vaccine. When cases of the disease occurred in spite of this vaccination the programme was changed to one which had been successful in industrial farms, vaccination at the age of one day at the farm with 'Bursaplex,' a vaccine promoted for this purpose. However, more recently cases of disease have appeared even with this vaccine, which led to the recommendation to give a second vaccination with an intermediate strain. The chicks raised by broody hens were found to be much more susceptible to fowl pox then the chicks raised in larger numbers in the chick rearing units. This may be due to contamination from the broody hen. Thus particular care had to be taken to vaccinate the chicks raised by broody hens. All the preceding discussion shows the importance of flexibility when using a vaccination programme: it is not sufficient to adopt a fixed programme from the beginning; it must be adapted whenever necessary.

The collaboration between the government veterinary and livestock officials and the project personnel has been very good in the best of cases, as evidenced by the good knowledge of the government officials with the cases of the different farmers. However, it has depended on the quality of the individuals involved.

Despite the precautions taken, cases of Salmonellosis did arise amongst parent birds. This underlined the inherent difficulties in enforcing the discipline necessary for bio security in a government (other than military) environment. However, treatment was possible in these cases.

Experience in collaborating with academic institutions in applied research programmes has shown that it is important for the project personnel to have a regular dialogue with the researchers to keep the research practically orientated, lest it become too academic. Research seminars, as well as practical contact in the field, provide suitable forums for this dialogue.

It is hoped that this discussion of the strategies used in this project will be helpful for those embarking on new projects of a similar nature. In any case, when we are dealing not only with the birds of the poorest of people, but also with birds purchased on credit, it is of paramount importance to give the utmost attention to disease control strategies.

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EXPERIENCES IN USING POULTRY AS A TOOL FOR POVERTY ALLEVIATION AT VILLAGE LEVEL — HOW TO ENABLE POOR WOMEN TO INCREASE THEIR INCOME

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Abstract

The Danida-financed Network for Smallholder Poultry Development (NSPD) has several years of experience in supporting family poultry development at village level by focusing on poor, in particular poor women. Traditionally women are caretakers of poultry in most poor countries. The poor mainly own small flocks of poultry: Poultry with a minimal production output. NSPD has developed a strategy, which involves not only disease control or introduction of improved breeds, but a holistic approach also taking social, cultural, marketing, credit and general management aspects into consideration. The tools to develop family poultry range from sensitisation of village groups and organisation of women in poultry groups to training of village vaccinators, farmer field schools for poor illiterate women, organisation of local vendors, use of private veterinarians, and finally involvement of national research, education and extension institutions. Results from Bangladesh, Vietnam, Benin, Senegal, Burkina Faso, Togo and Kenya are very promising in terms of creating non-subsidised activities with clear benefits for poor farmers as well as local entrepreneurs.

Keywords: Enabling environment, organisation, service delivery, micro finance, marketing, disease prevention, feeding

INTRODUCTION

Poultry production in most tropical countries is based mainly on scavenging production systems. It has been estimated that 80% of the poultry population in Africa is found in traditional scavenging systems (Gueye, 1998; Gueye 2000). Women and children are generally in charge of poultry husbandry (Anon, 2002). The birds scavenge in the vicinity of the homestead during daytime where they may be given sorghum, millet, maize bran, broken grains, or other waste products as supplementary feed. The level of productivity is very low compared to high-input systems; scavenging hens lay 30 eggs per year, while industrialised battery hens lay up to 300 eggs annually. Furthermore, it may take up to 12 months to raise a chicken for consumption. These production systems are entitled ‘low input-low output’ systems (Pandey, 1992). A range of factors such as sub-optimal management, lack of supplementary feed, low genetic potential and diseases (Pandey, 1992; Bagust, 1994 and 1999; Permin, 1997; Permin and Bisgaard, 1999), causes the low output. Despite the low production, scavenging chickens still accounts for a major part of all meat produced in many developing countries, where poultry is an important component of rural, peri-urban, and urban households. As such poultry plays a big role in rural as well as national economy (FAO, 2000; Mlodzi and Minga, 2003).

PROBLEMS RELATED TO VILLAGE POULTRY PRODUCTION

The most striking problem in relation to village poultry production is the high mortality: Mortality rates may be as high as 80–90% within the first year after hatching (Matthewman, 1977; Wilson et al., 1987; Kyvsgaard, 1999). Traditionally, Newcastle disease

(ND) is believed to be the most devastating disease in free-range systems and the main course of the high mortality (Minga, 1989; Aini, 1990; Bell et al., 1990; Kabatange and Katule, 1990; Bell, 1992). Other diseases may also cause high mortality rates in the absense of ND (Permin, 1997; Barman, 2002). However, many other factors affect the efficiency of poultry production either directly or indirectly. These include the genetic constitution of the host, nutrition (or malnutrition), environment, management and societal pressures that can interact in multiple ways influencing the ultimate productivity level, the overall mortality rate, the quality of the final product and marketing aspects (Calnek, 1998; Anon, 2002; Schou, 2004; Assoumane, 2004). Successful poultry production (and other agricultural business) includes the possibility of obtaining loans for further investments and improvements of the production. In village production only small loans are needed, but they are mostly impossible for the producers to get (Fattah, 1999). The village poultry production and the problems related thereto can be scheduled as in Fig. 1 (Permin and Pedersen, 2000).

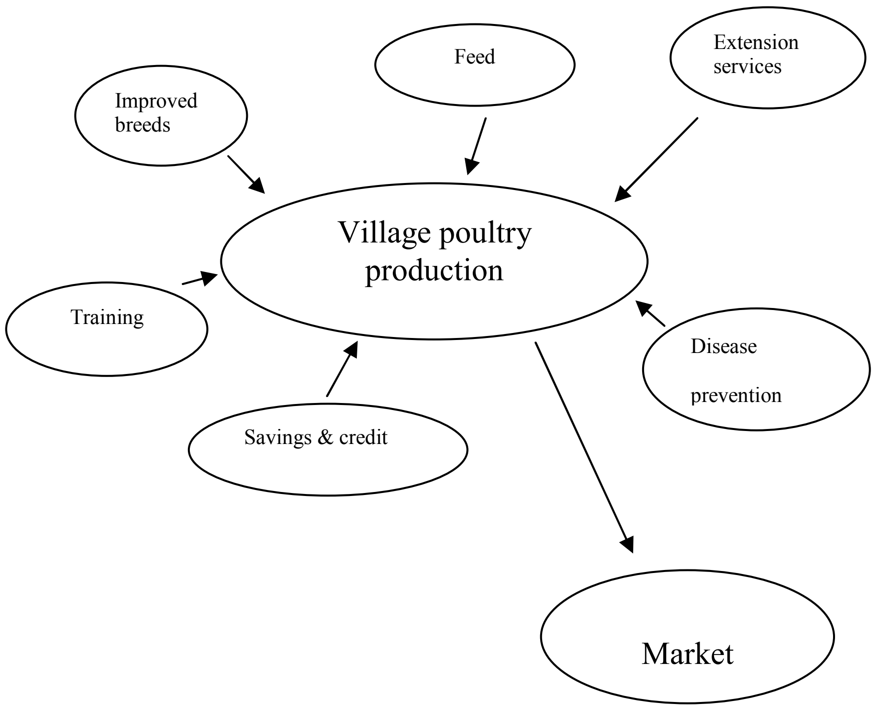

FIG. 1. The village poultry production and the problems related thereto

Village poultry production has over the years attracted some attention due to the enormous potential for increasing the output vis-à-vis the relatively low output at present. However, the view has been that traditional village poultry production could only be improved by preventing few diseases in the flocks and/or supplementing with feed. This point of view has, however, not lead to an increased production. The reasons for this lack of success may be quite obvious if Fig. 1 is analysed. Disease prevention and supplementing feeding only constitutes a part of the overall number of problems related to village poultry production. Recent experiences from Bangladesh, Vietnam, Benin, Burkina Faso, Senegal, Togo and Kenya have shown that it is possible to improve the poultry production at village level quickly, although the means to do so may differ from region to region.

The organisation of the smallholder poultry production support may be divided into a production line, a supply line and one or more service lines (Table I). In fact, the major challenge for improving poultry production at village level lies in the organisational aspects, not in the technical. Solutions for technical problems relating to disease, nutrition and management have long been known and applied in large-scale farming, but how to organize the production at village level for the benefit of small-scale farmers with 5–50 chickens remains a major task. The vast experience from Bangladesh (Askov-Jensen, 1996; Saleque, 1996; Alam, 1996 and 1997; Fattah, 1999 and Ahamed, 2000) has shown that it is possible to "atomize" an industrial system into small enterprises, whereby poor, often illiterate, women producers may earn a living from having only 5–10 egg-laying hens. However, the experience from Bangladesh is not directly applicable in an African or even Asian context.

TABLE I. THE VILLAGE POULTRY PRODUCTION MODEL. (ADAPTED FROM ASKOV JENSEN, 1996)

Production	Supply	Service (local)	Service (government)
Egg	Vaccine/medicine	Organisation and training of producers	Training of trainers
Meat	Feed	Savings and credit	Research
Dual purpose	Chickens (day-old)	Marketing	

STRATEGIES FOR SMALLHOLDER POULTRY DEVELOPMENT

A strategy for poultry development at village is based on a thorough analysis of the production in a given country including a market analysis (prices, product desires, deliveries) and production analysis (housing systems, diseases, feeds, breeds). The strategy for smallholder poultry development will therefore differ from area to area, from country to country based on the market analysis and production analysis.

The smallholder production line in Bangladesh usually consists of small-scale egg-producers (5–10 hens), small-scale chick rearers (200–300 chicks, 0–8 weeks), small-scale hatcheries (500–1000 eggs/month) and small-scale parent stocks (40–60 hens and 6–10 cocks) (Askov-Jensen, 1996). The integrated "Bangladesh Poultry Model" was developed over 20–30 years, and the strategies for starting new approaches in e.g. West Africa have naturally been different. Activities in Benin (Chrysostome et al., 2002), Burkina Faso (NSPD, 2003) and Senegal (Frederiksen and Permin, 2004) were initially organised around local chickens or guinea fowl for a dual-purpose egg and meat production, but with a clear marketing strategy focusing on sale of live birds and occasionally eggs for incubation. The marketing aspects are important when dealing with poultry production as an income generating activity. Fortunately, most studies on marketing aspects show no saturation for indigenous products on a local or even national level, whereas production of improved meat (broilers) or eggs needs more attention on the national and even global markets.

It is important to stress that when dealing with poultry as a means of addressing poverty, the risks involved in starting up or improving the production have to be minimal from a producer's point of view. Introducing new high-yielding breeds should be done in a careful step-wise manner, ensuring that producers know how to handle disease and management problems first. It is also necessary to recognise that the sale of a few eggs per day or a few live birds per month should have a remarkable effect on the income at household level. Otherwise, it makes little sense to focus on indigenous birds. Learning how to rear 5–50 local chickens is just the first step out of poverty, not a goal in itself (Dolberg, 2003).

INPUT SUPPLIES

From an organisational point of view, the supply of vaccines and medicine are essential. The first supplier to contract locally will thus be a veterinary service, either private or governmental. A veterinary service deliverer at minimum has to assure a sustained supply of vaccines against Newcastle disease (ND) and Fowl Pox, as well as drugs against coccidiosis and parasites. If vaccines against ND (and other prevailing diseases) cannot be delivered according to agreed schedules, small-scale poultry production will never succeed at village level (Alders et al., 2002). However, delivery is not enough, vaccination campaigns should preferably cover at least 60–80% of the poultry population to be effective against epidemic diseases, and this calls for the involvement of veterinary assistants or "barefoot vets" to cover the vast number of chickens in the villages. Village poultry programmes in Bangladesh have today trained more than 20,000 so-called poultry workers responsible for vaccinating village chickens. Recent experience from VSF-Togo (Bebay, 2003) shows that village vaccinators may earn a good income from vaccinating indigenous birds, and more interesting, private veterinarians earn a higher profit on selling drugs for poultry than for cattle. Feed supplies are another challenge in village-based poultry production systems. By reducing the supplementation given to adult birds to 40 g/day or less, the cost of production is reduced drastically (NSPD, 2002). It is possibly to keep up productivity, if adult birds are left scavenging for scraps and feeds during the day. In Bangladesh (Ahmed, 2000; Askov-Jensen, 1996) feed sellers have been trained in mixing local ingredients to semi-balanced feeds for different age-groups. In Burkina Faso (NSPD, 2003) and Benin (Chrysostome et al., 2002), small-scale producers were taught how to mix semi-balanced feeds themselves, as well as on techniques for collecting termites and growing maggots out of manure and waste.

To make development sustainable, input supplies are rarely subsidized. Activities in Burkina Faso, Benin and Senegal involved giving the first vaccination for free to show smallholders that vaccination works. Subsequently, vaccines and medication were sold at market prices including a vaccination fee for the village vaccinators. Activities in Senegal and Benin have involved small loans (30–50 USD/farmer) based on the so-called micro-credit systems approach, whereby farmers are acting as collateral for each other. Farmers pay back loans including an interest of 20–24% within the first year (Frederiksen, 2004; Nielsen, 2003). In general subsidies have been given mainly for organisation and training, and rarely for "hard" inputs such as housing materials (Frederiksen, 2004).

SERVICE LINES

The most important aspects in developing village based poultry production systems are "the soft parts", dealing with the social, cultural and economic context of the smallholders. A slow participatory sensitisation process of all village members, including village heads, women, children and men, is an essential starting point for the development of village-based poultry production focusing on the poor (Askov-Jensen, 1996; Frederiksen, 2004). Subsequently, the training aspects of the service delivery are important. Recent experience from Vietnam and Kenya shows how to develop participatory training approached for extension personnel as well as farmers based on the so-called Farmer Field School (FFS) principles (Khisa & Ondwasy, 2003; Riise et al., 2004). The basis of the FFS are groups of farmers, who decide with or without external support to start up common-interest- or -self-help groups, which meet regularly to share experience and exchange ideas on how to develop their production, market their products etc. Experience from e.g. Benin and Senegal show remarkable results on mean flock size after only one year of intervention (Fig. 2 and Table II). At the same time, the approach may be highly efficient in reaching out to poorer segments of the villages, as shown in Benin (Nielsen, 2003) and Bangladesh (Alam, 1997). Last but not least, it is crucial to attract national and international research programmes for developing village based poultry production systems. Recent results from a multidisciplinary Master of Science degree programme in Denmark have been remarkable in addressing issues relevant for small-scale farmers, and at the same time assuring a high standard of research to be published internationally (NSPD, 2002).

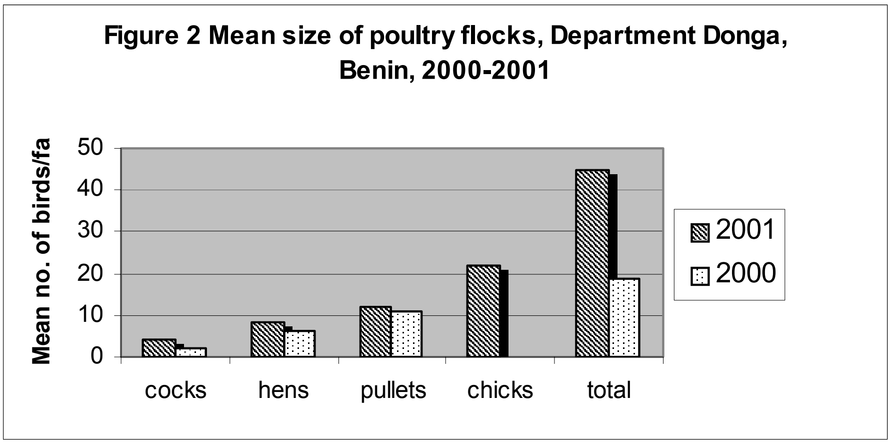

FIG. 2. Mean size of Poultry stock

TABLE II. MEAN FLOCK SIZE PER FARM AND TOTAL IN THREE VILLAGES IN KOLDA REGION, SENEGAL. (FREDERIKSEN, 2004)

Village	Month	Cocks	Hens	Growers	Chicks	Total	Mean/farm
	nov–02	177		117	0	294	13.5
Diourour	dec–03	39	146	188	150	523	17.4
	nov–02	257		159	0	416	14.9
Bayemba	dec–03	42	108	229	155	534	22.3
	nov–02	52		20	0	72	6
Dioulayel	dec–03	33	105	142	235	515	19.1

CONCLUSION

There are no secrets in how to improve village poultry production. By having a holistic approach to village poultry development, taking into account technical as well as organisational aspects, it is possible within a relatively short period to develop poultry production systems based on locally available resources, which may help the poorer farmers in developing their skills and creating a sustainable income with very few inputs. However, it requires involvement and commitment to help poor farmers at village level. Projects with long time perspectives are needed to ensure the sustainability of village development.

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COUNTRY REPORTS

THE EFFECT OF VACCINATION AGAINST NEWCASTLE DISEASE AND FEED SUPPLEMENTATION ON PRODUCTION IN VILLAGE CHICKEN IN BAMENDA AREA OF CAMEROON

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Abstract

A study was carried out in Ndop and Santa zones of the Bamenda area in the Republic of Cameroon on the effect of vaccination against Newcastle disease and feed supplementation on production in backyard poultry. The results of the study showed that there was an increase in egg production and weight gain in the vaccinated birds which received feed supplement as compared to the non-vaccinated and without feed supplements. The mortality pattern did not reflect the effect of feed supplementation suggesting that other factors may be responsible for mortality. An economic analysis of the impact of the two interventions on backyard poultry production was carried out using the partial farm budget analysis. It was evident from the results that feed supplementation was beneficial to rural poultry performance and that the inclusion of a vaccination programme against Newcastle disease made the intervention even more beneficial.

INTRODUCTION.

With the exception of urban areas of Northern and Southern Africa, most poultry production in Africa is undertaken through extensive system at village or family level. Almost every village household keeps domestic fowl between 5– 20 birds and it is estimated that village fowl makes up more than 80% of the total domestic fowl population in Africa estimated at 1068 million (Gueye, 1998).

Poultry keeping in Cameroon is largely dominated by the traditional system, which handles about 19 millions chicken representing about 70% of the total flock population. This system is called backyard and remains heterogeneous in terms of breeds or strains, housing and management systems. Despite the potential inherent to this traditional system, many constraints hinder its evolvement namely neglect by proprietors and policy makers, unimproved genetic materials, poor housing design, prevalence of Newcastle and Gumboro diseases and poor feeding (Nwosu, 1979, Ekue et al., 1999, Awan et al., 1994). Pandey, 1992; Aini, 1990; Bagust, 1994; Bagust 1994.

This paper is based on data generated after field interventions were done in 2002 on vaccination against Newcastle diseases, de-worming, feed supplementation, and on-the-job training of family poultry farmers on routine improved management techniques. The paper also highlights the economic impact of feed supplementation and vaccination against Newcastle disease.

METHODOLOGY

Area of study

The study was carried out in two zones (Santa and Ndop) located in the North West Province of Cameroon. The Santa zone is of high altitude (>1200 m above sea level (a.s.1) and the Ndop zone is of low altitude (<1200 a.s.l).

Farmer selection

Three villages were selected from each zone and four households from each village giving a total of 24 households or experimental units. While villages were chosen at random, care was taken to ensure that each household kept at least 10 traditional chicken of which at least 4 were adult hens. Moreover, in each village households were chosen to reflect the existing tribal settlements, either of the Fulani or the indigenous Grassfield settlers. Each group of settlers corresponded to specific environments, ways of life and poultry production/management patterns.

Interventions

Vaccinations

Intra-ocular vaccination against Newcastle disease using a locally available pack (HIPRAVIAR-BI) from Spain. A booster was administered to all the birds one month later. Birds from all the house holds were also dewormed using piperazine citrate.

Provision of feed supplement.

The chicken under study were allowed to scavenge, but in addition to this, their food was supplemented with compounded feed made of maize, (90%) and bone meal (10%). Seven out of the ten farmers in each zone were provided with feed, while the others served as control. A handful of feed was provided to chicken every morning before they were allowed to scavenge assuming that each bird would get about 60 gm of feed supplement daily.

Data collection and analysis

Field data on egg production, body weight change and mortality were collected monthly during visits to farms implicated in the vaccination programme by researchers, research technicians and extensionists. The data collected were subjected to the process of data reduction to obtain organised information, which was stored in a spreadsheet program (excel 2002). Descriptive analysis was conducted on the production data collected from individual household.

Economic analysis of the vaccination programme was conducted using farm partial budgeting procedures as outlined by Goodger et al. (2000). The farm budgeting procedures included the six steps outlined by Goodger et al. (2000) and summarized as follows:

- establish a baseline data in order to calculate the additional income generated from the programme;
- deduct the additional annual income as a difference between the average income while on the programme and the estimated income before the programme started;
- estimate the program costs by listing cost values of each input;

- calculate the profit by subtracting from the program costs those of additional income generated;
- calculate the return on investment by dividing the additional income from the program by the program costs;
- the criteria for a successful intervention is a dollar income >$1 or a return >$1.

The economic data collection scheme was as follows:

The baseline data was that of 1999 (Ekue et al., 1999). These data were obtained after two years of project life during which interventions were implemented sporadically. After the survey, additional interventions as stated above were implemented in selected households. Monitoring took place from January to March 2003, during which time data were collected on farm productivity. The differences between these two values helped to build up the partial budgeting parameters.

Data were kept on market prices of chicken products, flock size and variations due to mortality, sales, purchases, home consumption, gifts or predators. The field vaccination cost was determined following procedures outlined by Alders et al. (2002).

RESULTS AND DISCUSSION

Results in Table I show the egg production and chicken mortality through a three-month period (dry season) when farmers experienced shortage of feedstuff such as maize grains to provide their chicken. Seven out of 10 farms were served with feed to supplement their feeding. The amounts of feed fed to chicken were not quantified. Average egg production per household increased with feed supplementation in both zones (Santa zone: 23 versus 15 eggs and Ndop zone: 8 versus 4 eggs for feed supplementation and non supplementation, respectively).

The mortality pattern did not reflect the effect of feed supplementation. This suggests that other factors in addition to feed may be responsible for mortality.

TABLE I. EGG PRODUCTION OF CHICKEN SUBJECTED TO DIFFERENT FEED TREATMENTS.

Feed treatment	Location	Total egg number	Average egg number /clutch	Maximum number /clutch	Minimum number	Chicken mortality per household
Feed	Santa	938	22.8	42	3	4.5
supplement	Ndop	924	8.1	49	3	3.8
Non feed	Santa	394	14.5	45	1	4.8
supplement	Ndop	102	3.8	26	1	7.4

Table II shows monthly weight gain as recorded in various farms. The unsexed and the female average weight increased with feed intervention in both Santa and Ndop zones. However, no explanation can be forwarded for the reverse situation observed for male chicken in Ndop zone.

TABLE II. MONTHLY WEIGHT GAIN OF CHICKEN SUBJECTED TO DIFFERENT FEED TREATMENTS.

Traits	Location					
	Santa and Ndop		Santa		Ndop	
	Feed	Non feed	Feed	Non feed	Feed	Non feed
Average weight gain (g)	150	89	96	68	184	148
Female average gain (g)	124	39	55	39	158	140
Male average gain (g)	222	336	180	385	278	200

ECONOMIC ANALYSIS OF THE FIELD INTERVENTIONS

The use of computed database provided partial budgets for Ndop, Santa and both zones combined, respectively (Tables III and IV).

TABLE III. PARTIAL BUDGETING RESULTS FOR NDOP ZONE FOR THE PERIOD JANUARY– MARCH 2003.

INCREASED INCOME (FCFA) Additional income generated from the program			INCREASED COSTS (FCFA) Costs as a result of the program	
Sales and other off take	Before intervention	18.257	Vaccination	469.7
	After intervention	18.862	Other medical costs	27.3
Difference in income		605.7	Total costs	497.0
Income minus costs (Profit margins			108.7	
Income-costs ratio			1.219	

TABLE IV. PARTIAL BUDGETING RESULTS FOR SANTA ZONE FOR THE PERIOD, JANUARY– MARCH, 2003.

INCREASED INCOME (FCFA) Additional income generated from the program			INCREASED COSTS (FCFA) Costs as a result of the program	
Sales and other off take (Home consumption; gifts, etc.)	Before intervention	18336	Vaccination	515.19
	After intervention	25003	Other medical costs	36.98
Difference in income		6667	Total costs	552.17
Income minus costs (Profit margins			6114.9	
Income-costs ratio			12.07	

CONCLUSION

From this field study, it was evident that feed supplementation was beneficial to rural chicken performance and that the addition of vaccination program made the intervention even more beneficial in Ndop zone. For most of the households that implemented the interventions, the increase in the total number of chicken raised represented a significant improvement in diet, hygiene, clothing, medication, schooling and other family requirements. In fact, some farmers boasted of their improved social status because they could now easily afford one or two cocks for various ceremonies in the village and this was not the case in the past. Despite the significant improvement in village poultry production as a result of vaccination against Newcastle disease on the one hand and feed supplementation on the other, there is still a major constraint on the production and availability of the Newcastle disease vaccine at the village level. It is important for the National Veterinary Laboratory (LANAVET), Garoua, to start the production of thermostable vaccines packaged in small doses affordable to the poor farmers.

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CORRELATION BETWEEN NEWCASTLE DISEASE VACCINES AND PESTICIDES POLLUTION IN VILLAGE CHICKEN

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Abstract

The prevalence Newcastle disease in vaccinated chicken under the effect of pollution with pesticides was studied. Six hundred day-old- native chicks were distributed in two areas. The first area used pesticides in competing parasite infections in agriculture crops while the second area did not use any pesticides. The prevalence of Newcastle disease in free-range village chicken was calculated by retrospective data analysis, cross section studies and the combination of serological survey and virus isolation. The presence of the pesticides Diazinol, Malathion and Trichlorofon was analysed by Thin Layer Chromatography (TLC). Diazinon, Malathion and Trichlorofon were detected in the chick sera in the first area. The prevalence of Newcastle disease in the polluted areas is higher than non-polluted areas. The rate of Newcastle disease is directly proportional to the quality and the quantity of pesticide pollutants in the sera. Newcastle antibody titers are inversely proportional to the quality and the quantity of pesticide pollutants in the sera. Morbidities and mortalities of Newcastle disease were higher in challenged chicken their sera had higher pesticide pollutants. The average body weights were lower in chicken feed on ration contaminated with pesticide pollutants.

INTRODUCTION

The main feed of free-range chicken is harvest leftovers, grains, worms, kitchen residues vegetables, insects or/and household scraps. These chicken face two main problems, one of them is nutritional deficiency and the other is pesticide pollution. These two problems might have an adverse effect on the immune system of the bird so it gets more susceptible to infectious diseases and with high economic losses as a result

Newcastle disease virus constitutes a serious problem in most countries of the world. It is responsible for high mortalities among poultry population. Though several types of vaccines are produced against the Newcastle disease such as Hitchner B_1, Lasota and inactivated vaccines. Yet still Newcastle disease is widely spread and outbreaks appear even in vaccinated farms. Lentogenic vaccine strains are used widely at different ages. (Zaher *et al*., 1962; Ahmed and Sabban, 1965; El-Sissi, 1966 and Ahmed *et al*., 1967). The NDV immune response increases as the pathogenicity of live vaccine increases (Reeve *et al*., 1974).

Lasota vaccines are recommended for the protection of chickens at different ages due to efficacy and safety. The antibody levels reached protect the vaccinated chicks against NDV infections. This protection depends on recurrent infection and factors affecting the immune systems of the susceptible birds. Environmental factors, including pollution have been implicated in increase diseases infections among animals and birds. Previous studies of laboratory animals and wildlife species have demonstrated the immuno-toxicity of pesticides (Grasman and Fox, 2001). Although the relation between pesticide under natural conditions and the immune response during vaccination campaigns has not been studied.

The use of Diazinon, Malathion and Trichlorofon on golf courses and sod farms has been prohibited because of their high acute risk to birds Gilman *et al*. (1991). However

Diazinon, Malathion and Meterifonate are commonly used in Egypt in agriculture or for veterinary purposes and can be traced in chicken.

The aim of our paper is to study the prevalence of Newcastle disease in vaccinated chicken under the effect of pollution with pesticides

MATERIALS AND METHODS

Study area

Sharkia and Giza districts were two ecological zones selected for this field study. The first area is situated east Cairo. This area is a new reclaimed area and characterized by producing vegetables and fruits as well as high use of pesticide to control the plant parasites. The 2nd area is situated south of Cairo and did not use any pesticides for agricultural purposes.

Chicken

Source of chicken: Six hundreds day-old native chicks (Balady) were bought from the EL-Azab project in the province of Fayoum.

The number of chicken and their distribution is summarized in Table I.

Shelter and management: The chicks were allowed to scavenge during the daytime and were sheltered at night (Traditional type).

Vaccination

All chicken were vaccinated against NDV and IBDV.

IBDV vaccine: Live intermediate commercial Gumboro (Bursimune, Biomune vaccines) vaccine was given by eye drop at the age of one–day.

NDV vaccine: Chicken were vaccinated, via eye drop route, with Hitchner B1 strain (Intervet vaccines Co.) at the age of 7 days and with La Sota strain (Respimune, Biomune vaccines co.) via oral route, at the age of 19, 30 and 60-day.

IBDV and NDV vaccines were given according to the manufacture recommended doses and procedures.

Feed

The main feed consisted of household scraps, farm by-products and the chicken had to scavenge around for the remaining part of their nutritional requirements.

Source of water: The ground water without prior treatment was the main source in all farms.

Blood samples

Five blood samples were collected from all houses on day 1 followed by week-old, 1, 2, 3, 4, 8 and 12 weeks. The sera were separated and kept for NDV serology tests and pesticide residue analysis at –20˚C.

Challenge study

At the end of the observation period (when the chicken were12-weeks old), ten birds were bought from each group and challenged with a 10^6 EID_{50}/ml of the field VNDV strain by intramuscular route. Morbidity and mortality rates during this study were recorded. These were done at the experimental section at the Animal Health Research Institute.

Haemagglutination inhibition (HI) test

The HI tests against NDV using 4 heamagglutinating units were done by the Beta procedure. The HI titers were determined in all chickens, and the geometric mean titer (GMT) of each group was calculated.

Pesticide residue analysis

Serum samples were examined qualitatively for presence of the three pesticides (Diazinon, Malathion and Trichlorfon) using Thin Layer Chromatography (TLC) with methanol as solvent and heptan : dimethylformamide (90 : 10) as eluent and then detected by R_f value in consideration as mentioned by Fried and Sherma (1996). Positive samples were quantitatively examined according to Hernandez *et al*. (2002) and Clarke (1984).

Post-mortem lesions and NDV isolation

At the Animal Health Research Institute (AHRI) all sick and dead birds were brought for clinical, post-mortem examinations and NDV isolation.

Observation period

All farms were observed from one-day-old until 84-day-old. At the end of the experiment all chicken were weighted and the average body weight was calculated.

Statistical analysis

- Morbidities and mortalities either during observation period or due to challenge with NDV.
- NDV antibody titers.
- Qualitative and quantitative of Diazinon, Malathion and Trichlorfon residues in sera.
- Average body weight.

The data was subjected to analysis of variance (ANOVA) and means compared for significance using Least Significant Difference as well as Duncan Multiple Range Test for comparative of means at $P < 0.05$ on a computer program. Economical benefit value was calculated using χ^2 square test at $P < 0.05$ (SPSS 11, 2002).

RESULTS

In spite of various vaccination programs against NDV, infection continued to be a major problem in flocks of native breed in Egypt. Usually the native flocks are vaccinated several times with live NDV vaccines during the growing period and production period but the results are not satisfactory.

In this study the main concern was directed to evaluate the relation between Pesticides and commercially NDV vaccines in village chickens and the results were as follow:

Morbidities and mortalities

At each house natural outbreaks of NDV was verified by isolation of NDV from birds that succumbed to the disease within the trail time (Table II). The recorded morbidities were 16%, 15%, 12%, 10%, 7% and 5% in houses 1, 3, 5, 2, 4 and 6 respectively while the mortalities were 14%, 12%, 11%, 6%, 6% and 4%.

NDV signs

Signs of NDV were sudden death, facial edema sever whitish, greenish or darkish diarrhea, drooping wings, reluctant to move, lack of appetite, difficulties in breathing, coughing, sneezing, gasping and sometimes leg paralysis and nervous signs.

Post-mortem lesions

NDV lesions were congested visceral organs, petecheal ecchymotic haemorrhage on intestinal and coloacal mucosa, haemorrhage on tips of proventricullus villi and cecal tonsils, pneumonic lungs, severe tracheitis and enteritis.

The diagnosis of NDV was confirmed by virus isolation from sick and dead birds with subsequent characterization according to Office international Des Epizooties (OIE) Manual of Standards for Diagnostic Tests and Vaccines (1992).

Results of challenge

In the challenged birds (Table III), the recorded morbidities were 60%, 50%, 50%, 30%, 30% and 20% in houses 1, 3, 5, 2, 4 and 6 while the mortality were 50%, 50%, 40%, 20%, 10% and 10% respectively.

NDV antibody titers

Table IV reveals that, there was little evidence of NDV antibody in the chicken before the trails. The vaccinated chicks gave immunity against NDV, which is better in houses 6 and 4 then 2, 5, 3 and 1 respectively.

Detection of pesticide residues

Quantities of pesticide residues in different positive serum samples (ppm) showed the presence of Diazinon, Malathion and Trichlorfon in serum with significant concern ($P < 0.05$) using analysis of variance and house 5 was significantly the highest in Diazinon residues; house 1 was the highest in Malathion residues while house 3 was the highest in Trichlorfon residues in serum at $P < 0.05$ using LSD (Tables, 5 and 6).

Correlation between pesticide and NDV antibody titer

From Tables IV, V and VI it is clear that there are a detectable significant limit of pesticide residues and significant decline in NDV antibody titers in tested sera in groups 1, 3 and 5 which means that there are a significant correlation between pesticide residues and NDV titer at $P < 0.05$ using LSD.

TABLE I. CHICKEN NUMBERS AND DISTRIBUTION.

House	Number *	Pesticide uses	Source	Governorate
1	100	+	Native	Sharkia
2	100	+	commercial	Sharkia
3	100	+	breed	Sharkia
4	100	+		Sharkia
5	100	+		Sharkia
6	100	–		Giza

*All chicks in all houses were vaccinated as follow:
1-day-old IBDV by eye route.
7-day-old HB1 by eye route.
30-day-old LaSota by eye route.
60-day-old LaSota by eye route

TABLE II. MORBIDITY, MORTALITY AND BODY WEIGHT IN OBSERVED HOUSEHOLDS.

House	Morbidity		Mortality		Average body weight/Grams
	Number	%	Number	%	
1	16	16	14	1	675
2	10	10	6	2	875
3	15	15	12	3	775
4	7	7	6	4	875
5	12	12	11	5	805
6	5	5	4	6	1000

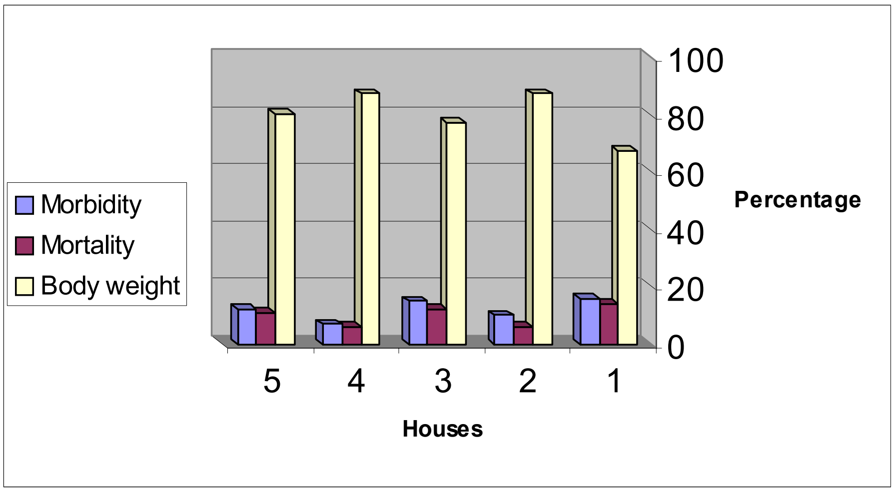

FIG. 1. Morbidity, mortality and body weights in households due to natural NDV

TABLE III. MORBIDITY AND MORTALITY IN NDV-CHALLENGED BIRDS.

House	Morbidity Number	%	Mortality Number	%
1	6	60	5	50
2	3	30	2	20
3	5	50	5	50
4	3	30	1	10
5	5	50	4	40
6	2	20	1	10

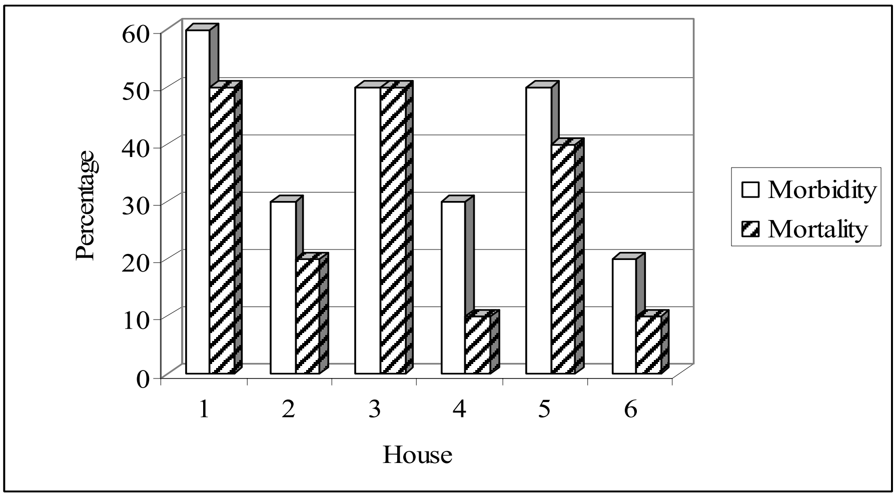

FIG. 2. Shows morbidity and mortality in NDV-challenged birds

TABLE IV. NDV GEOMETRIC MEAN TITER BY HI.

House	1 day	1st week	2nd week	3rd week	4th week	8th week	12th week
1	5	4	6	6	5	6	5.5
2	5	4	6	7	6	7	7
3	5	4	6	6	5	6	6
4	5	4	6	7	6	7	7
5	5	4	6	6.5	5.5	6.5	6.5
6	5	4	6	8	6	7	7

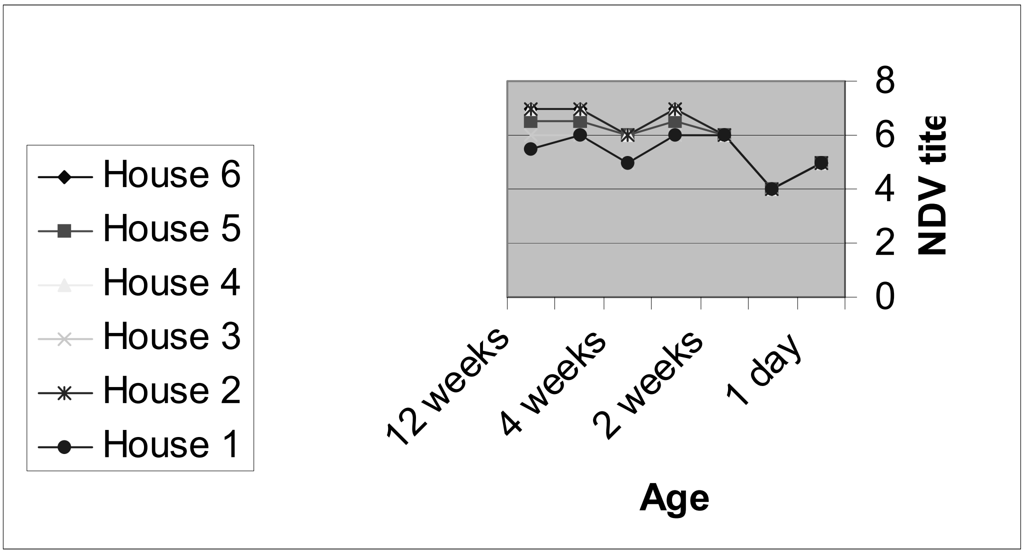

FIG. 3. NDV Geometric Mean Titer by HI

TABLE V. POS. PESTICIDE RESIDUES SAMPLES, NUMBER AND PERCENT IN SERUM AND CORRELATION WITH NDV USING THE SPEARMAN METHOD.

Hou	1st week		2nd week		3rd week		4th week		8th week		12th week		Cor-relation
	No	%	No	%	No.	%	No	%	No	%	No	%	
1	4	1.33	3	1.00	5	1.67	4	1.33	2	0.67	1	0.33	0.424**
2	0	0.00	5	1.67	0	0.00	3	1.00	3	1.00	5	1.67	0.198
3	1	0.33	4	1.33	1	0.33	0	0.00	4	1.33	0	0.00	0.303*
4	2	0.67	4	1.33	1	0.33	1	0.33	2	0.67	3	1.00	0.031
5	0	0.00	2	0.67	5	1.67	1	0.33	3	1.00	0	0.00	0.284*
6	-ve	0	-ve	0	-ve	0	-ve	0	-ve	0	-ve	0	0

* Significant at $P < 0.05$ using Spearman correlation
** Significant at $P < 0.01$ using Spearman correlation

TABLE VI. THE QUANTITY OF PESTICIDE RESIDUES IN DIFFERENT POSITIVE SERUM SAMPLES (PPM).

House	Diazinon	Malathion	Trichlorfon
1	0.65 ± 0.12	1.31 ± 0.24	0.08 ± 0.03
2	0.98 ± 0.12	0.61 ± 0.12	0.07 ± 0.009
3	1.15 ± 0.15	0.82 ± 0.26	0.11 ± 0.06
4	1.35 ± 0.13	0.91 ± 0.31	0.03 ± 0.04
5	1.41 ± 0.29	1.11 ± 0.35	0.07 ± 0.01
F-calculated	6.542#	11.324#	9.658#
LSD	0.257	0.298	0.019

* Significantly different using ANOVA test at $P < 0.05$ LSD = Least Significant Difference

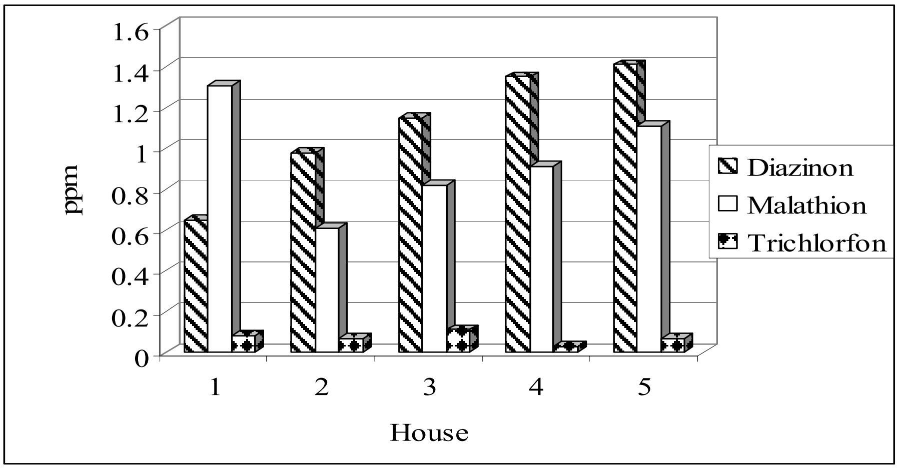

FIG. 4.Ppesticide residues in different positive serum samples (ppm).

TABLE VII. ECONOMICAL ANALYSIS OF RESULTED DATA BY L.E. (EGYPTIAN POUND).

House	No. of chicken	Cost	Vic. cost	Total cost	No. Live	*Average body Weight	**Total body Weight	Sales	Benefit	Benefit/ Unit
1	100	80	2.5	82.5	86	0.675	58.05	464.4	381.9	5.629
2	100	80	2.5	82.5	94	0.875	82.25	658	575.5	7.975
3	100	80	2.5	82.5	88	0.775	68.2	545.6	463.1	6.613
4	100	80	2.5	82.5	94	0.875	82.25	658	575.5	7.975
5	100	80	2.5	82.5	89	0.805	71.645	573.16	490.66	6.947
6	100	80	2.5	82.5	96	1	96	768	685.5	9.309
Chi-Square									18.93 ***	

* Average body Weight/grams square test.
** Total body Weight/kg
*** Significant at $P < 0.05$ using Chi

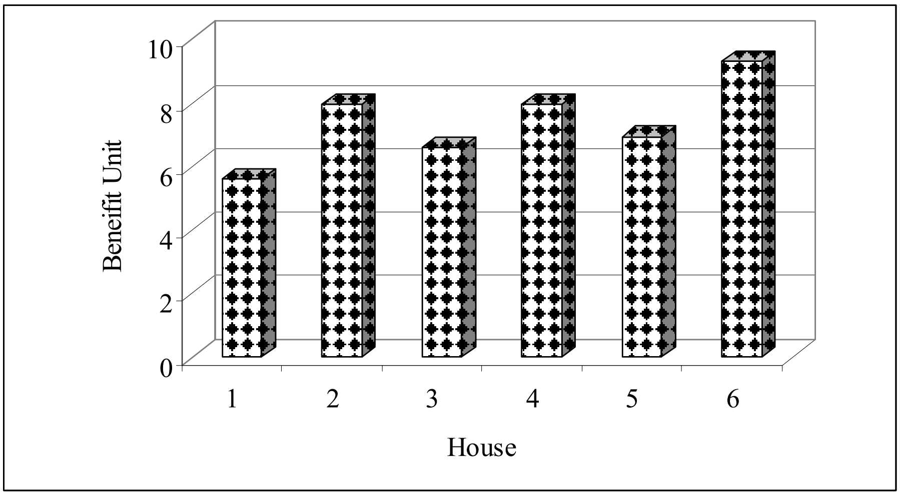

FIG. 5. Economic benefit values of different houses.

DISCUSSION

The relation between vaccination response and pesticide pollution under natural condition has not been studied. Newcastle disease is considered one of the most important disease among different age groups of free-ranging rural chicken which causes severe economic losses due to an increase number of morbidities, mortalities and drop in egg production in laying chicken. The highest benefit degree of controlling morbidities and mortalities depends on suitable media and factors lead to the success of vaccination against the disease.

The present work revealed that the Newcastle disease was most prevalent in areas with a high pesticide pollution. In this respect D'Mello (2002) reported that environmental factors, including pollution have resulted in an increase of infections among animals and birds.

The NDV symptoms appeared suddenly in peracute or acute forms and the post-mortem lesions were more pronounced and more acute when compared to birds not having completely polluted feed, which is in agreement with Alexander *(1997).* Serology of the tested sera using the HI test revealed that Newcastle antibody titers were lower in highly pesticide polluted farms. This correlates with results obtained by Grasman and Fox (2001) who demonstrated the immunotoxicity and immunosupression of pesticides in laboratory animals and wildlife species.

The correlation between NDV antibody levels and the quantity of pesticides pollution in the sera of tested chicken was calculated by using the Spearman correlation method. This proved a positive correlation between studied parameters in household number 1 at $P < 0.05$; 2 and in household number 3 at $P < 0.01$.Our finding agreed with those obtained by Bishop *et a*l. (1998) who observed drastic effect of pesticide on the immune system and its development in 16-day-old Tree Swallow (Tachycineta bicolor) birds. Grasman *et al*. (2000) recorded the positive correlation between pesticide exposure and immune status of 3-week-old herring gulls (*Larus argentatus*) from six sites on Lakes Superior and observed a significant decrease in immuno-globulins of the studied birds. Also, Grasman and Fox (2001) showed an association between organ chlorines and suppressed T cell function and enhanced antibody production in young Caspian terns, they added that there was a significant drop in total antibody titers following immunization with sheep red blood cells. The titers were positively correlated with plasma PCBs and DDE.

CONCLUSION

The results obtained in the 6 villages are extremely challenging due to:

- Lack of knowledge about nutrient pollutants, which is considered a serious problem for householders and a limiting factors for production.
- In order to control of the economic losses due to infectious diseases, its recommended to use suitable vaccine as well as a feed free of pesticide pollution .
- Above all the farmers were satisfied with the results and motivated to invest more inputs to improve the poultry production system.

At the end, householders are extremely interested in seeing the possibility of controlling other diseases under village conditions and are looking forward to extent the project.

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PREVALENCE OF GUMBORO DISEASE IN VACCINATED AND NON-VACCINATED VILLAGE CHICKENS IN EGYPT

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Abstract

In order to investigate the incidence of Gumboro disease virus (IBDV) in village poultry in Egypt, 3000 one-day-old Balady chicks were distributed to 60 householders keeping free- ranging chicken (traditional) with an average of 50 chicks/ household. These were put under observed from one-day-old until seventy days of age and visited once a week.

On 30 of these household farms the one-day-old chicken were vaccinated before delivery with an intermediate IBDV strain while the chicken on the other 30 farms were not vaccinated. Fifteen of each vaccinated and unvaccinated householder farms had other avian species while the other fifteen of each vaccinated and unvaccinated householders had not. The clinical symptoms, post-mortem and serological results using the Agar Gel Immuno-diffusion test (AGID) revealed that Gumboro disease is one of the most important diseases in rural chicken. Mortality rates were very high (5–32%) and decreasing body weights due to IBDV infection were significant, especially in chicken reared with other avian species.

Results from the survey showed the significant efficacy of IBDV classical vaccine in one-day-old chicken. It showed a decrease in mortality and an increase in body weight gain on vaccinated farms independent whether they were kept with other avian species.

Vaccination programs to control Gumboro disease would be an advantage in traditional poultry farms.

INTRODUCTION

Rural poultry production is an important agricultural activity in almost all developing communities in Africa and elsewhere, providing animal protein in the form of meat and eggs as well as being a reliable source of petty cash. Gumboro usually occurs in young chicken while turkeys and ducks may be infected (Lukert and Saif, 1997). The acute form causes high morbidity and high mortality discouraging householders from paying proper attention to the husbandry and welfare of this attention. More over chicken traders also suffer from huge financial losses due to IBDV mortality in chicken, particularly those who buy young aged chicken and rear them for several weeks after purchase. This can cause secondary problems due to the effect of the virus on the bursa fabricii. It causes lymphoid depletion of the bursa. If this happen in the first week of life significant depression of the humeral antibody response may result.

Infectious bursal disease virus (IBDV) was first described by Cosgrove (1962) in USA, and was recorded in Egypt by El-Sergany *et al*., (1974). The perpetuation of IBD in commercial flocks is attributed to the highly resistant nature of the virus and the emergence of pathogenic and antigenic variants (Lukert and Saif, 1997). This acute IBD also spread to Egypt (El-Batrawy, 1990). Although commercial chickens and breeding flocks are routinely vaccinated with live and inactivated classic vaccines, acute outbreaks are still reported in Egypt. It is apparent that available classic vaccine and vaccination strategies need to be re-evaluated especially against recently emerged IBDV.

The objective of this study was to observe the current situation of Gumboro disease (IBDV) in village chickens and to study the benefit of using classic intermediate IBDV commercial vaccine at one-day-old in a small unit of village chickens.

MATERIALS AND METHODS

Location and description of the study area

Sixty households were randomly selected and put under our observation. These households were located in Giza, Sharkia, Dakahlia, and Kalubiah provinces, which are located in South, East, North and Middle Egypt respectively (Table I). On 30 of these householder farms the day-old chickens were vaccinated with IBD intermediate strain by our team before delivery. Fifteen of each vaccinated and non-vaccinated householder farms had other avian species of birds (Ducks, Geese, Turkeys, Pidgins, mixed age and/ or older chickens) while the other fifteen of each vaccinated and non-vaccinated householders only had the delivered chicken.

TABLE I. DISTRIBUTION OF RURAL FARMS SURVEYED IN PROVINCES.

Province	Number of farms							
	Unvaccinated				Vaccinated at 1-day-old			
	Had other avian species	Flock size	Had no other avian species	Flock size	Had other avian Species	Flock size	Had no other avian species	Flock size
Giza	4	223	4	198	4	246	4	229
Dakahlia	4	193	4	165	4	252	4	238
Kalubia	4	146	4	134	4	173	4	162
Sharkia	3	150	3	128	3	164	3	154
Total	15	712	15	625	15	835	15	783

NB. Forty-five chicks died during transportation.

Number and source of chicks: Three thousands one-day-old Balady chicks were bought from EL-Azab project, Fayoum province and divided as shown in Table I.
Shelter and management: Chicks were allowed to scavenge during the day time and sheltered at night (traditional type) and had no regular health control programmes.
Ration: The main food was little bit of household scraps, farm by products and the scavenged feed
Source of water: Ground water without prior treatment was the mainly source in all farms.
IBDV vaccine: Live intermediate commercial Gumboro (Bursimune, Biomune vaccines) vaccine was given by eye drop at day one in a recommended dose.
Observation period: All farms were put under our observation from one-day-old until seventy day of age. These farms were visited once a week.

Sample collection and handling

- Blood samples from morbid chicken were collected from the wing vein with 3ml syringes and put in a cool box. Serum was separated from the blood and kept at –20°C until examination .
- Fresh dead chicken were collected for post-mortem examination.
- Bursa of Fabricius was collected from dead birds.
- All these were transported to the Animal Health Research institute Laboratory in a cool box for further examination.

IBDV antigen. The IBDV (FB99, type 1) was isolated from a local outbreak in Fayoum province by Hassan, *et al*. (2002) and used for preparation of specific antisera and antigens according to Office International des Epizooties (OIE) Manual of Standards for Diagnostic Tests and Vaccines (1992).

IBD was suspected on the basis:

- Clinical signs specific to IBDV Disease.
- Number of morbidity specific to IBDV Disease.
- Number of mortality specific to IBDV Disease.
- Post-mortem lesions specific to IBDV Disease.

IBD confirmation was done by:
Serological tests: Agar gel immuno-diffusion test (AGID) is the most useful serological tests for detection of specific antibodies in serum and/or for detecting virus antigen in bursal tissues. Ouchterlony double immuno-diffusion test for detection of IBDV in bursal homogenates and IBDV antibody in the tested sera were conducted as described by the OIE Manual of Standards for Diagnostic Tests and Vaccines (1992).

Data collected

- Morbidity and mortality numbers were gathered from poultry owners.
- Registration of the clinical signs and post-mortem lesions.
- Detection of IBDV antibody in the collected sera.
- Detection of IBDV antigen from the collected bursae.
- Average body weight at the end of the observation.
- The price of the one-day-old chicks.
- The cost of the vaccine dose per chick.
- The sale price of one kg chicks.

Statistical analysis

The data was subjected to analysis of variance (ANOVA) and means compared for significance using Least Significant Difference as well as Duncan Multiple Range Test for comparison of means at $P < 0.05$ on a computer program. Economical benefit value was calculated using χ^2 square test at $P < 0.05$ (SPSS 11, 2002).

RESULTS

Clinical signs and Post-mortem lesions

In the morbid chicks typical IBD mortality patterns (sharp death curve and rapid recovery) were noticed. Clinical signs were whitish diarrhoea, anorexia, dehydration, depression, trembling, prostration and death. On post-mortem examination, characteristic IBD lesions were noticed including dehydration, muscular haemorrhages, enlarged hemorrhagic bursa, urates in ureters and congested kidney.

The relative morbidity of different farms is listed in Table II.

The main results obtained were:

- The age of susceptibility in Balady chicken to Gumboro disease is ranged from 21–45-day-old.
- The relative IBDV mortality was higher in chicken reared with other avian species than those reared with other avian species.
- The prevalence of Gumboro disease was higher in chicken reared with other avian.
- The body weight gain was less in chicken reared with other avian species than those not reared with other avian species.
- The using of intermediate IBDV commercial vaccine at day-old gave satisfactory results.
- It is better to rear young aged chicks separately.

TABLE II. INCIDENCE OF GUMBORO IN VACCINATED AND NONE-VACCINATED HOUSEHOLDER CHICKEN IN EGYPT.

Type of farm	Treatment	No. of farm	Total No. of birds	Morbidities due to IBDV infection		Mortalities due to IBDV infection		IBDV Antigen detection/ dead birds		IBDV Antibody detection /morbid birds	
				No.	%	No.	%	No.	%	No.	%
Had other Avian species	Unvaccinated	15	712	270	38%	227	32%	119	32%	270	100%
	Vaccinated	15	835	134	16%	75	9%	21	9%	134	100%
Hadn’t other avian species	Unvaccinated	15	625	200	32%	150	24%	62	24%	200	100%
	Vaccinated	15	783	102	13%	39	5%	9	5%	102	100%

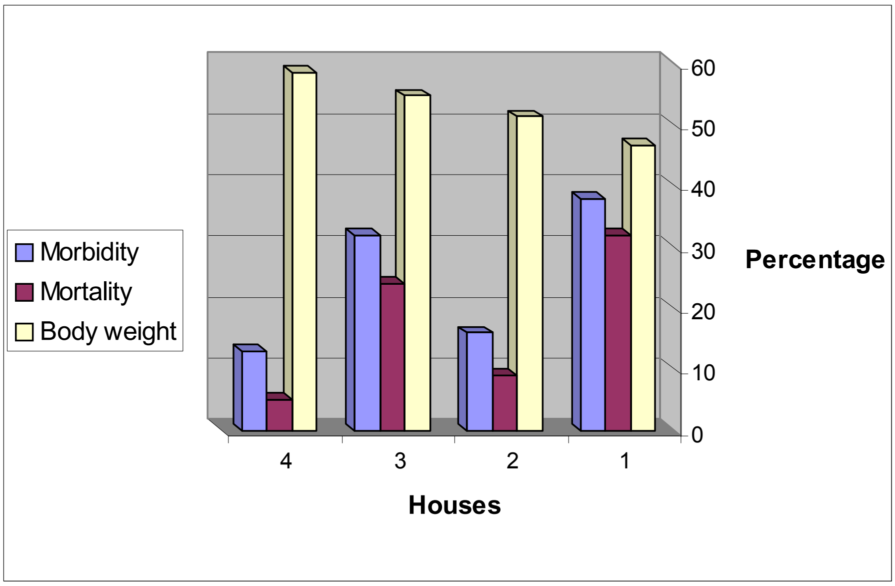

FIG. 1. Incidence of Gumboro in vaccinated and non-vaccinated householder chicken in Egypt.

DISCUSSION

The evolution of IBDV during the last two decades has caused heavy economic losses for the poultry industry worldwide. In Egypt, little information is available about the biological characteristics of prevailing IBDV in rural chicken. This study showed that acute IBDV must be considered as a major health hazard that constrains family poultry production with morbidities from 13 to 38% and mortalities from 5 to 32%.

The results proved that the prevalence of Gumboro disease is higher in chicken reared with other avian species than those that not been kept with other avian species either on farms with vaccination or no vaccination against IBDV vaccine. This could be explained in part by the role of other avian species as carriers to transmit the IBDV to the chicken. Giambrone *et al*. (1978) reported that IBDV infection in turkeys were subclinicaly producing microscopic lesions in the bursa only.

Bumstead *et al.* (1998) mentioned that variations in breed susceptibility have been documented for many poultry diseases. Okoye, and Aba-duluga (1998) reported that local Nigerian chicken were more susceptible to IBD than exotic chicken.

The source of IBDV infection in the observed flocks could not be identified. This may be due to the presence of other avian species as well as a lot of mosquitoes and rats. The latter were higher in numbers than reared chicken. Howie and Thosen (1981) isolated IBDV from mosquitoes (Aedes vexan) that were trapped in an area where chicken were being raised. Okoye and Uche (1986) detected IBDV antibodies from blood samples of rats which found dead in four poultry farms that had histories of IBDV infection.

The sharp death curve, rapid recovery, the clinical signs and the post-mortem lesions correspond with observation in IBDV infections of Leukert and Saif, (1997). They reported that whitish diarrhoea, anorexia, dehydration, depression, trembling, prostration and death, muscular haemorrhage, darkened discoloration of pectoral muscles, enlarged hemorrhagic cloacal bursa, urates in ureters and congested kidneys are characteristics for IBDV.

The relative mortality in different farms in our investigation were 32% in unvaccinated farms which other avian species, 9% in vaccinated farms with other avian species, 24% in unvaccinated with no other avian species and 5% in vaccinated farms with no other avian species.

Generally the mortality was high in all the farms compared to commercial farms which not exceeds 1% under ideal conditions. Moreover the relative mortality in the farms with other avian species was higher than those farms without other avian species and this may be due to the recurrent IBDV infection of the chicken from other avian carrier species which were reared with them. This situation is similar to what have been reported by Aini (2002) who stated that mortality in chicken is very high in developing countries where family poultry is a source of income to the rural population. Faouzy *et al.*, 2002 found that NDV and IBDV diseases caused high mortality reaching 70% in village chicken in Morocco. Allan *et al* (1972*)* and Faraghter *et al* (1974) reported immunosuppressive effects of IBDV infections and birds are more susceptible to infectious diseases than other non-infected birds.

On the other hand, the present study showed the positive effect of using commercial IBDV vaccine at one-day-old chicken. The mortality in the unvaccinated breeds was higher than in the vaccinated breeds. This is in agreement with Hassan *et al*. (2002 and 2003) who found that the response of vaccinated and non-vaccinated native Egyptian breeds to infection with very virulent infectious bursal disease virus (vvIBDV) were not more than 3% and not less than 10% respectively. The difference between our results and Hassan *et al*., 2002 and 2003 may be due to that they did their experiments on pure breeds, under laboratory conditions and chicken feed on suitable balanced ration.

Our results showed that the levels of IBDV antibody in the morbid chicken were not paralleled by the recorded IBDV mortality rates in the same flocks. This may be due to the fact that mortality occurs after infection as determined by the humeral immune response as reported by Hassan *et al*, 2002.

The significance of the decrease in body weight may be due to poor quality of food, poor shelters and the presence of other avian breeds playing a great role in transmitting infectious diseases.

TABLE III. ECONOMIC ANALYSIS.

Treatment	No. of chicken	Price cost	Vacc. Cost	Total cost	No. Live*	Average B. Weight	Total B. Weight	Sales	Benefit	Benefit/ Unit
Unvac. + Av.	712	569.6	0	569.6	442	0.468	206.9	1860	1290	4.3
Vac. + Av.	835	668	20.8	688.8	701	0.514	360.3	3243	2554	6.7
Unvac.	625	500	0	500.0	425	0.548	232.9	2096	1569.i	5.4
Vac.	783	626.4	19.5	645.9	681	0.586	399.1	3591	2945	7.5

*After deducing the morbid chicken.

Unvac. = Unvaccinated, Vac. = Vaccinated, Av. = Avian, B.= Body, Chick price = 0.8 LE, Price of 1 kg.= 9LE, Vaccine coast/chick= 0.025

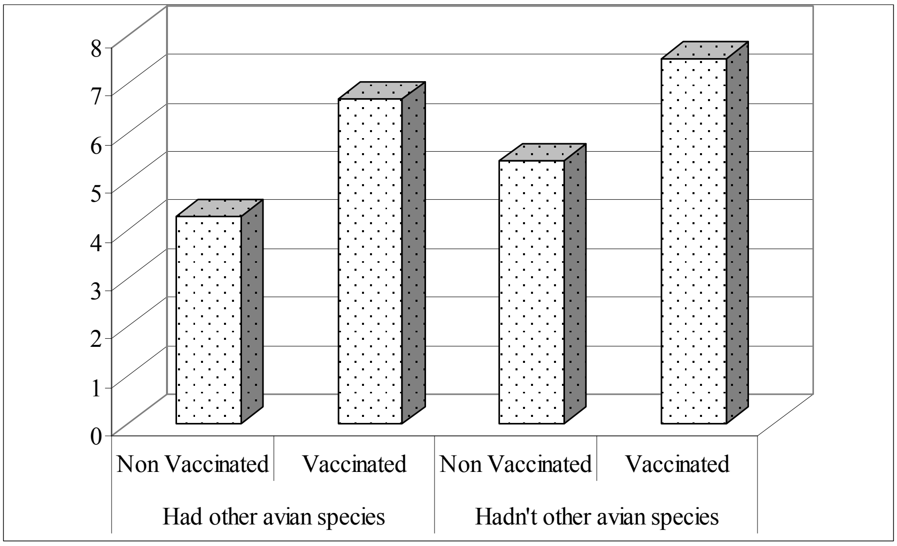

FIG. 2. Comparison of benefit/unit gain from vaccinated and unvaccinated if had or had not other avian species in household.

CONCLUSION

IBDV vaccine was an important key to return investment for Family Poultry production in Egypt by making a vital contribution to the improvement of household farm, food security and poverty alleviation.

Rearing of young chicken separately form other avian species is beneficial in family poultry production.

Control of IBDV in village chicken farms could be useful in preventing IBDV infection in commercial chicken.

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CONTROL OF VERY VIRULENT INFECTIOUS BURSAL DISEASE (VVIBDV) IN RURAL POULTRY IN EGYPT

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Abstract

Day-old local Balady chicks, with maternally derived antibodies to Infectious Bursal Disease (IBD) and Newcastle disease (ND), were reared in separate pens on a commercial farm. At 1 and/or 14 days old, the chicks were vaccinated with commercial live intermediate and/or hot vaccines against IBD. Also chicks were vaccinated against ND at 7, 19 and 29 days old. Sera samples were collected weekly to monitor the IBD and ND immune responses. At 28, 35 and 42 days old, chicks were transferred to the laboratory and challenged with very virulent IBD virus to evaluate the protection given by the vaccination programs. In all vaccinated groups, IBD maternal antibody interfered with development of active antibody response for the first 3 weeks of life followed by significant elevation of IBD antibodies at 28 days of age. The serological response to ND vaccines was not significantly affected in chicken vaccinated with intermediate or hot IBD vaccines. There was no significant difference in administrating live IBD vaccine either at 1 day old and/or 14 days old. Based on the results of this study, it is recommended to vaccinate day-old local chicks, before delivery to small holders, with live IBD vaccine despite the temporary interference by maternal antibody. Key words: Infectious bursal disease virus, rural Egyptian chicken, immunogenicity, and classic vaccine.

INTRODUCTION

Balady chickens are indigenous, dual-purpose Egyptian breed, characterized by small body size, different colours of plumage. It is difficult to describe Balady chickens as pure breed. Despite intensive poultry production systems in Egypt, local chicken production continues to play a significant socio-economic role in rural areas. Recently, local chickens have been raised in semi intensive farms and fed commercial feeds.

Economic losses due to infectious diseases represent a major constrain facing the expansion of local chicken production. In this regard, Infectious Bursal Disease (IBD) represents a significant challenge to both commercial and village chicken production. IBD causes fatal or immunosuppressive effect in young chickens (Lukert and Saif, 1997). During the late 1980s, acute IBD was recorded in Europe and Africa and was attributed to the emergence of pathotypic variants of the virus known as very virulent IBD viruses (vvIBDV) (Chettle *et al.*, 1989; El-Batrawy 1990; Van den Berg, 2000; Abdel-Alim and Saif, 2001). In Egypt, Hassan *et al.* (2002, 2003) reported that six of seven Egyptian local chickens were highly susceptible to vvIBDV. Unfortunately, no statistics are available about the incidence and loses due to IBD in village chickens.

In the semi-intensive local chicken production, different vaccination programs are usually adopted during the first few weeks of life. Under village conditions, due to lack of education and limited access to veterinary services, IBD vaccination is difficult and rarely practiced by the small holders who cannot afford to purchase vaccine vials with 1000 doses to vaccinate few numbers of chickens.

This study was conducted to examine the immunogenicity induced against challenge with vvIBDV by the use of combinations of live vaccines and different vaccination programs in local Balady chickens as well as the effect of IBDV vaccines on the response of birds vaccinated against Newcastle disease.

MATERIALS AND METHODS

Chickens

In this study, chicks were derived from breeders vaccinated against IBD and ND using live vaccine followed by inactivated IBD and ND vaccines before point of lay. Birds were received as one-day-old chicks and were bled to monitor maternal IBD and ND antibodies. Chicks were reared in clean, disinfected pens in a commercial farm and were provided with food and water *ad libitum.*

IBD vaccines

Chickens were vaccinated, using the eye drops, with one dose of commercial intermediate and/or hot live vaccines (Bursimune vaccine, Biomune vaccines Co. and Ibd blen, Ceva Vaccines co. respectively) as recommended by vaccine producers of the mentioned companies.

NDV vaccine

Chickens were vaccinated, using eye drops, with Hitchner B1 strain (Intervet Vaccines Co.) at 7 days old and with the La Sota strain (Respimune, Biomune vaccines co.) via oral route, at 19 and 29 days old.

IBD challenge virus

The vvIBD challenge virus (FB99) was isolated from a local outbreak in Fayoum province (Hassan *et al*., 2002). In this experiment, a dose of 10^2 CLD_{50} per bird was used.

Haemagglutination inhibition (HI) test

The HI test was used to test for NDV using 4 haemagglutinating units (Beta procedure). The HI titres were determined in all chickens.

IBD antibody ELISA

Individual blood samples were taken from 5 chicks/ group and both individual and GMT for each group was calculated using commercial Kit soft ware (IBD, IDEXX lab. Inc., Maine, USA).

Pathology

Bursa fabricii were fixed in 10% buffered formalin, stained with hematoxylin and eosin, and scored for histological lesions as described by Rosales *et al.,* (1989). The bursal lesions were subjectively scored as: 1= no lesions, 2= focal, mild cell depletion, 3= multifocal, 1/3 to 1/2 of follicles show atrophy, 4= diffuse atrophy of all follicles.

Experimental design

Four hundred day-old Balady chickens were brought and divided into 3 major groups (A, B and C) and kept in separate pens on a commercial farm. Details of the IBD vaccination regimes are shown in Table I. Briefly, Chickens in groups A were given one dose of live hot IBD vaccine and at 14 days the old birds were divided into 3 subgroups (1, 2 and 3). Chickens in group B were given one dose of live intermediate IBD vaccine and at 14 days old the birds were divided into 3 subgroups (5, 6 and 7). Group C was subdivided into 4 subgroups (4, 8, 9 and 10). Chickens in groups 4 and 8 were vaccinated at 14 days old with hot and intermediate vaccines, respectively. Chickens in groups 9 and 10 were maintained as positive controls (unvaccinated and challenged) and negative controls (unvaccinated and unchallenged). Starting at 7 days old and at weekly intervals thereafter until 7 weeks, chickens (5 birds per group) were tested by ELISA and HI test to monitor both IBDV and NDV antibodies. At 28, 35 and 42 days old, 10 birds from each group were transferred to the laboratory and challenged via the eye drop route with 0.1 ml of the vvIBDV challenge virus containing 10^2 CLD_{50} per bird. Birds were necropsied 7 days after challenge (PC) and the mean Bursa Fabricii: Body weight (BF: BW) ratios, bursal lesion score and serum antibody titers to IBDV were determined.

Statistical analysis

Significance of difference of the mean B: BW ratios, antibody titres of the inoculated and control birds and the geometric mean titer (GMT) of each group was calculated and determined by analysis of variance and Fisher's least significant difference test. Statistical significance was determined at the 0.05 probability.

TABLE I. EXPERIMENTAL DESIGN OF IBD VACCINATION PROGRAMS OF BALADY CHICKENS USING INTERMEDIATE (INTR.) AND/ OR HOT IBDV VACCINES.

Group[A]	Age	
	Day old	2 weeks old
1	Hot vaccine	Hot vaccine
2	Hot vaccine	Intr. Vaccine
3	Hot vaccine	–
4	–	Hot vaccine
5	Intr. Vaccine	Intr. Vaccine
6	Intr. Vaccine	Hot vaccine
7	Intr. Vaccine	–
8	–	Intr. Vaccine
9[B]	–	–
10[B]	–	–

[A]Each group contained 40 birds and chicken was vaccinated via eye drop route with live intermediate and/or hot IBDV vaccine.
[B]Group 9 is unvaccinated-challenged controls; Group 10 is unvaccinated-unchallenged controls.

RESULTS

Throughout the observation period of 2 months, mortality rates in vaccinated and control birds were within the range of 1.0% per month. Chick liveability was considered to be normal. No clinical signs of IBD were noted post vaccination with intermediate and hot vaccines.

Monitor of IBDV and NDV maternal antibodies

As shown in Table II, day-old chicks had high maternal IBD antibody titres prior to vaccination. At 21 days old, serum from most vaccinated and control chickens did not contain demonstrable IBDV antibody. Starting at 28 days old, the levels of IBD antibody in vaccinated chickens significantly increased regardless of the vaccination program. The monitoring of NDV antibody is illustrated in Table III. Maternally derived ND antibody persisted in chickens until 21 days of age (group 9). The levels of NDV antibody were roughly similar in IBD vaccinated groups.

Protection of vaccinated chicks against vvIBDV challenge

Results of the challenge experiments conducted at 28, 35 and 42 days of age, are recorded in Tables III, IV and V. All 8 vaccination-programs were capable of protecting challenged chickens against both mortality and clinical IBD signs. The unvaccinated challenged chicks (group 9) showed typical IBD signs (prostration, ruffled feather and diarrhoea) and lesions (muscular and/or proventricular haemorrhage, renal injury, bursal edema and haemorrhage) at three days post challenge. No clinical signs of IBD were noted in the unvaccinated unchallenged birds throughout the experimental period. The BF:BW ratios of the challenged vaccinated birds were not significantly different (P>0.05) from those of negative controls (group 10). The bursas were examined histologically for lesions and scored. The severity of the lesions was regarded as moderate to severe in vaccinated chickens and severe in unvaccinated challenged birds.

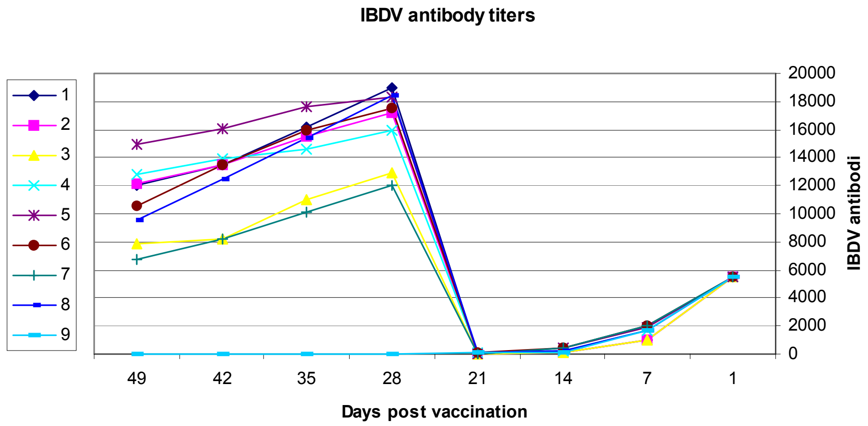

FIG. 1. IBDV antibody titers and the geometric mean titre (GMT) of each group were calculated. chickens vaccinated with intermediate and/or hot IBDV vaccines at 1 and/or 14 days of age.

TABLE II. IBDV ANTIBODY TITERS IN CHICKENS VACCINATED WITH INTERMEDIATE AND/OR HOT IBDV VACCINES AT 1 AND/OR 14 DAYS OF AGE.

Group	Age (Days)							
	1	7	14	21	28	35	42	49
1	5522	1052	110	38	19002	16204	13521	12065
2	5522	1052	110	50	17224	15504	13506	12136
3	5522	1052	110	53	12956	10986	8194	7854
4	5522	1676	280	107	16001	14590	13924	12771
5	5522	1957	499	16	18276	17679	16074	14974
6	5522	1975	499	123	17485	15995	13526	10594
7	5522	1975	499	47	11995	10060	8160	6725
8	5522	1676	280	168	18468	15381	12462	9528
9	5522	1021	79	83	0	0.0	0	0

[A]Geometric mean titre (GMT) for 5 chickens per group. Values lower than 260 are considered negative.

TABLE III. MONITOR OF NEWCASTLE VIRUS ANTIBODY TITRES IN CHICKENS VACCINATED WITH INTERMEDIATE AND/OR HOT IBDV VACCINES AT 1 AND/OR 14 DAYS OF AGE.

Group	Age (Days)				
	1	7	14	21	49
1	6.0	4.2	2.4	1.4	2.9
2	6.0	4.2	2.4	1.6	5.6
3	6.0	4.2	2.4	3.4	3.2
4	6.0	4.6	2.7	1.8	5.8
5	6.0	4.4	3.8	1.5	2.4
6	6.0	4.4	3.8	1.2	3.2
7	6.0	4.4	3.8	0.4	3.2
8	6.0	4.6	2.7	2.4	3.8
9	6.0	5.6	2.8	0.8	0.0

[A]Geometric mean titre (GMT) for 5 chickens per group

TABLE IV. RESULTS OF CHALLENGE EXPERIMENT CONDUCTED AT DAY 28. BURSA: RECORDED PARAMETERS AT DAY 7 POST CHALLENGE.

Group[A]	Bursa: body weight ratios[B]	Bursa lesions score[C]	IBDV antibody titres[D]	Dead/ total challenged
1	1.52 [a]	2/2/2/4/4	23842	1/10
2	1.93 [a]	2/2/3/4/4	22859	0/10
3	1.33 [a]	2/3/3/3/4	19671	1/10
4	1.15 [a]	2/3/3/4/4	17089	0/10
5	1.81 [a]	2/2/4/4/4	18095	0/10
6	1.36 [a]	2/2/3/3/4	19707	0/10
7	1.19 [a]	3/3/3/4/4	11723	0/10
8	1.47 [a]	2/2/2/3/4	14378	1/10
9[E]	0.88 [b]	4/4/4/4/4	19233	3/10
10[E]	2.10 [a]	1/1/1/1/1	0.0	0/10

[A]Each bird was inoculated with 0.10 ml of vvIBDV containing10^2 CLD_{50} of vvIBDV via eye drop routes.
[B]Values are average for 5 birds. Values within a column followed by different lower-case superscription are significantly different ($P<0.05$).
[C]Bursal lesion scores: 1= no lesions, 2= focal, mild cell depletion, 3= multifocal, 1/3 to 1/2 of follicles show atrophy, 4= diffuse atrophy of all follicles.
[D]Geometric mean titre (GMT) for 5 chickens per group.
[E]Group 9 is unvaccinated-challenged controls; Group 10 is unvaccinated-unchallenged controls.

TABLE V. RESULTS OF CHALLENGE EXPERIMENT CONDUCTED AT DAY 35. BURSA: RECORDED PARAMETERS AT DAY 7 POST CHALLENGE.

Group[A]	Bursa: body weight ratios[B]	Bursa lesions score[C]	IBDV antibody titres[D]	Dead/ total challenged
1	1.70 [a]	1/1/2/3/3	18986	0/10
2	1.86 [a]	1/2/2/2/3	19046	0/10
3	1.63 [a]	2/3/3/3/4	9572	1/10
4	1.41 [a]	2/2/3/3/4	7623	0/10
5	1.54 [a]	1/2/2/2/3	13491	1/10
6	1.64 [a]	2/2/3/3/3	18393	0/10
7	1.58 [a]	2/2/2/3/3	15565	1/10
8	1.39 [a]	1/2/2/2/3	11788	0/10
9[E]	0.69 [b]	4/4/4/4/4	14573	4/10
10[E]	2.19 [a]	1/1/1/1/1	0.0	0/10

[A]Each bird was inoculated with 0.10 ml of vvIBDV containing10^2 CLD_{50} of vvIBDV via eye drop routes.
[B]Values are average for 5 birds. Values within a column followed by different lower-case superscription are significantly different ($P<0.05$). [C]Bursal lesion scores: 1= no lesions, 2= focal, mild cell depletion, 3= multifocal, 1/3 to 1/2 of follicles show atrophy, 4= diffuse atrophy of all follicles. [D]Geometric mean titre (GMT) for 5 chickens per group. [E]Group 9 is unvaccinated-challenged controls; Group 10 is unvaccinated-unchallenged controls.

TABLE VI. RESULTS OF CHALLENGE EXPERIMENT CONDUCTED AT DAY 42. RECORDED PARAMETERS AT DAY 7 POST CHALLENGE.

Group[A]	Bursa: body weight ratios[B]	Bursa lesions score[C]	IBDV antibody titres[D]	Dead/ total challenged
1	1.24 [a]	1/2/2/2/3	10237	0/10
2	1.63 [a]	1/2/2/3/4	11706	1/10
3	1.21 [a]	1/2/2/3/3	13015	0/10
4	1.33 [a]	2/2/3/3/4	15851	0/10
5	1.34 [a]	1/2/2/3/4	16406	0/10
6	1.19 [a]	2/2/2/3/3	11969	1/10
7	1.14 [a]	2/2/2/4/4	16850	0/10
8	1.53 [a]	1/2/2/3/4	11678	1/10
9[E]	0.80 [b]	4/4/4/4/4	12960	4/10
10[E]	2.10 [a]	1/1/1/1/1	0.0	0/10

Day 28	Cost chick	vaccine	Feed	Total	Score No. life	Price	Mort	Titre	Total
1(H/H)	10	0.50	13	21.50	9	32.4	2	5	7
2(H/I)	10	0.50	13	21.50	10	36.0	3	4	7
3(–/H)	10	0.25	13	21.25	9	32.4	2	3	5
4(I/I)	10	0.25	13	21.25	10	36.0	3	2	5
5(H/H)	10	0.50	13	21.50	10	36.0	3	4	7
6(I/H)	10	0.50	13	21.50	10	36.0	3	4	7
7(I/–)	10	0.25	13	21.25	10	36.0	3	1	4
8(–/I)	10	0.25	13	21.25	9	32.4	2	0	2
9(–/–)	10	0.00	13	21.00	7	25.2	1	0	1
10(–/–)	10	0.00	13	21.00	10	36.0	3	0	3

Day 35	Cost chick	vaccine	Feed Price	Total coast	No. life	Sale price	Score Mort	Titre	Total
1(H/H)	10	0.50	13	21.50	10	44.0	3	4	7
2(H/I)	10	0.50	13	21.50	10	44.0	3	4	7
3(–/H)	10	0.25	13	21.25	9	39.6	2	1	3
4(I/I)	10	0.25	13	21.25	10	44.0	3	0	3
5(H/H)	10	0.50	13	21.50	9	39.6	2	5	7
6(I/H)	10	0.50	13	21.50	10	44.0	3	3	6
7(I/–)	10	0.25	13	21.25	9	39.6	2	5	7
8(–/I)	10	0.25	13	21.25	10	44.0	3	4	7
9(–/–)	10	0.00	13	21.00	6	26.4	1	0	1
10(–/–)	10	0.00	13	21.00	10	44.0	3	0	3

Day 42	Cost chick	vaccine	Feed price	Total	No. life	Sale price	Score Mort	Titre	Total
1(H/H)	10	0.50	13	21.50	10	57.6	3	4	7

2(H/I)	10	0.50	13	21.50	9	51.8	2	4	6
3(–/H)	10	0.25	13	21.25	10	57.6	3	2	5
4(I/I)	10	0.25	13	21.25	10	57.6	3	4	7
5(H/H)	10	0.50	13	21.50	10	57.6	3	5	8
6(I/H)	10	0.50	13	21.50	9	51.8	2	4	6
7(I/–)	10	0.25	13	21.25	10	57.6	3	2	5
8(–/I)	10	0.25	13	21.25	9	51.8	2	3	5
9(–/–)	10	0.00	13	21.00	6	34.6	0	0	0
10(–/–)	10	0.00	13	21.00	10	57.6	3	0	3

[A]Each bird was inoculated with 0.10 ml of vvIBDV containing10^2 CLD_{50} of vvIBDV via eye drop routes.
[B]Values are average for 5 birds. Values within a column followed by different lower-case superscription are significantly different ($P<0.05$). [C]Bursal lesion scores: 1= no lesions, 2= focal, mild cell depletion, 3= multifocal, 1/3 to 1/2 of follicles show atrophy, 4= diffuse atrophy of all follicles. [D]Geometric mean titre (GMT) for 5 chickens per group. [E]Group 9 is unvaccinated-challenged controls; Group 10 is unvaccinated-unchallenged controls.

DISCUSSION

Although local Egyptian chickens are well adapted to the ecological conditions in rural areas, they are much more susceptible to vvIBDV than exotic chickens (Hassan *et al.,* 2002, 2003). Therefore, control of IBD is of prime importance for profitable village (small holder) production.

Prior to the evolution of vvIBDV, conventional control of IBD in young chicks was achieved by the transfer of maternal derived antibodies (MDA), which protected the chicks until an age where infection is less detrimental in terms of immuno-supression during the early few weeks of life (Box, 1989). Therefore, parent flocks were vaccinated with inactivated vaccine before laying. However, with the emergence of vvIBDV, it was not possible to relay only on MDA and it became necessary to vaccinate young chicks, during the first few weeks of life, with intermediate vaccines (Van den Berg and Meulemans, 1991). Live IBD vaccines of intermediate virulence are widely used but with only partial success in endemic areas (Zouelfakar *et al.,* 1997). This was attributed to the ability of vvIBDV to infect chickens at early age in the presence of MDA titres too high to allow intermediate vaccine to elicit active immune response. Therefore, more invasive (hot) vaccines were introduced to induce better protection against vvIBDV, however, may induce marked bursal lesions especially in chickens with low titres of MDA.

In this study, it was noticed that vaccination of day-old chicks by intermediate and/ or hot vaccines was ineffective in eliciting significant IBD antibody response during the first 21 days of age (Table II). This could be attributed to the interference with IBD maternal antibody (Lucio and Hitchner, 1979). In fact such interference was temporary in nature and was followed by marked antibody response noticed in all vaccinated groups at 28 days of age, regardless of the vaccination program (Table II). This observation could be explained by Lukert & Rifuliadi, (1982) who reported that in chicks with MDA, the vaccine virus replicates in the thymus, spleen and cloacal bursa, where it persist for 2 weeks. Once the maternal antibody is catabolized, there is a primary antibody response to the persisting vaccine virus.

The results of the challenge study conducted at 28, 35 and 42 days old (Tables III, IV and V) demonstrated that all 8 IBD vaccination programs were effective in protecting against both mortality and clinical IBD but not against bursal damage. This observation suggests that the highly invasive nature of the challenge virus (Hassan *et al.* 2002).

Another objective of this study was to determine whether IBD vaccination (especially hot vaccine) had immunosuppressive effect on the antibody response to vaccination against ND. The results given in Table III illustrated no immuno-suppression was noticed as the HI titres were not significantly different in IBD and ND-vaccinated groups (P>0.05). Fortunately, MDA against IBD alleviated the side effect of the hot vaccines.

In conclusion, the concept of IBD vaccination of day-old chicks with MDA is valid despite the encountered interference. Therefore, it is recommended to vaccinate day-old local chicks, before delivery to small holders in rural areas.

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COMPREHENSIVE APPROACH TO THE IMPROVEMENT OF RURAL POULTRY PRODUCTION IN GHANA

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Abstract

The rural poultry production systems in Ghana and in Africa as a whole face a number of both health and husbandry problems which greatly limit their improvement. In the survey carried out earlier to highlight these problems, Newcastle disease was acknowledged as the biggest constraint. Next to this are diseases such as fowl pox, endo and ecto parasites. Poor husbandry practices such as lack of proper housing resulting in high incidence of predation, insufficient supplementary feeding are other factors that have further covered up 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. Reported here are the approaches adopted in the implementation of intervention measures. This has been in two phases. The first phase was based on the strategic control of Newcastle disease through a comparative study of the effectiveness of a thermostable vaccine (NDI-2) and an oil-adjuvant inactivated vaccine in the protection of rural chicken against virulent Newcastle disease. The second phase is concentrated on showing how an improved supplementary feeding can influence the growth rate of rural chicken, their maturation, chick survival and productivity in terms of number of eggs per clutch, fertility, and hatchability.

INTRODUCTION.

The world's population today stands at 6.2 billion, with 75 percent of this living in a state of malnutrition, at least in quality especially deficient in protein. A diet based on cereal grains (millet, paddy rice, wheat) and supplemented with leguminous vegetables (beans, peas) can cover the biggest part of the protein needs of the population. On the other hand, nutritional balance cannot be attained with only a combination of leguminous vegetables, poor in sulfur amino acids (cystine, methionine), and roots and tubers equally deficient in these same amino acids [1].

Proteins of animal origin, by their richness and balanced content in amino acids, considerably increase the nutrition of diets, even when supplied in small quantities. These animal proteins are a capital element in nutritional balance especially for vulnerable groups such as young children and pregnant women.

Poultry farming represents one of the ways in which Africa has engaged in to increase its production of animal protein. It offers the best yield in converting vegetable calories into high yield animal protein. Village poultry production is widely practiced in Africa especially among rural communities. The Village poultry production systems of Africa are mainly based on the scavenging indigenous chicken found in virtually all villages and households. These systems are characterized by a minimal or no incoming supply in terms of feed and medications with low productivity. Nevertheless, over 70 percent of the poultry products and 20 percent of animal protein intake in most African countries come from village poultry. Therefore, increasing rural poultry production would result in a positive impact on household food security both in increased dietary intake and income generation [2].

However, it is sad to note that rural poultry is not rated highly in the mainstream of 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 with relatively high mortality rates [3, 4]. Especially young chicks die in large numbers. Several reasons for this high mortality and low productivity have been suggested, such as sub optimal management, malnutrition, predation, disease, and poor quality if any of supplementary feeding [5, 6, 7, 8, 9].

Among the disease affecting rural poultry, Newcastle disease has been acknowledged as the greatest factor hindering to the improvement of rural poultry production in Africa being response for losses of over 80 percent of household poultry annually [5, 8, 10, 11, 12, 13]. Other diseases such as fowl pox, colibacillosis, endo and ecto parasites 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 potentials of the rural chicken.

Therefore programs aimed at the improvement of rural poultry production in Africa must be all embracing, focusing on the effective control of diseases (Newcastle disease, fowl pox, parasites) as well as encouraging a nutritionally balanced supplementary feeding.

STUDY I

COMPARATIVE ADVANTAGE OF A THERMOSTABLE I-2 VACCINE IN THE PROTECTION OF RURAL CHICKEN AGAINST NEWCASTLE DISEASE IN GHANA.

BACKGROUND

For time immemorial, the oil-adjuvant inactivated vaccine has been used in the protection of rural chicken against Newcastle disease. However, vaccination coverage has always been very low resulting in an insignificant protection of the rural chicken flocks with the consequent annual high mortalities of the birds to Newcastle disease. A number of factor account for this, and paramount amongst these are; –

- High cost of the vaccine making it unaffordable to most rural chicken farmers,
- The transportation of the vaccine requires strict cold chain facilities, which are not available in the rural communities.
- Administration of the vaccine requires specific professional skills. This is usually an added cost to the farmer.
- The vaccine can only be given to adult chickens leaving chicks unprotected and they are usually ribbed off during outbreaks of Newcastle disease.
- The route of application of the thermostable ND I-2 can be transferred to farmers and this promises a much wider vaccination coverage.

The aim of the study was therefore to compare the effectiveness of the thermostable ND I-2 vaccine, which is being produced locally, and the oil-adjuvant in the protection of rural chickens against challenges with virulent field Newcastle virus strains, with the view to replacing the latter with the former.

MATERIALS AND METHODS

The materials used for the study are: –

- Thermostable Newcastle disease (NDI-2) vaccine produced locally from a Master seed provided by the John Francis Veterinary Laboratory, Department of Virology, University of Queensland, AUSTRALIA.
- Oil-adjuvant Inactivated Newcastle disease vaccine for parental administration, virus strain Brescia > 108ELD50, Institute Zooprofilactico, distributed by CHEMNI DE LA MILLETIRE, BP 7562, 37073, TOURS, CEDEX 2, FRANCE, Batch No. 2518
- Isolated vilogenic field strain of the Newcastle disease virus, Isolated in 10-days old chicken embryo, with a Mean Embryo death Time (MDT) of 36 hours.
- Eye drop applicator for the administration of the thermostable I-2 vaccine calibrated to deliver 10-ul of vaccine dose per drop.
- Chicken feather stripped to carry 10ul 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 these zones four villages were selected for the study. In each ecological zone, the rural chickens of four women farmers in one village were wing tagged and vaccinated against Newcastle disease using the Thermostable ND I-2 vaccine by the eye-drop route twice at an interval of three weeks, in a second the vaccine was administered by feathers brushing of the eye also twice at the same interval of three weeks. Chickens in the third village were vaccinated with the oil-adjuvant inactivated vaccine by subcutaneous injection only once as has always been the practice. The fourth village was left as the control with the chickens not vaccinated at all.

Blood was taken from all the chicken before the commencement of the vaccinations, and also before the second vaccinations with the thermostable I-2 vaccine and three weeks afterwards. The birds vaccinated once with the oil-adjuvant inactivated vaccine and the controls were also bleed at the same time intervals.

Monitoring of the immune responses due to the vaccinations was by serology (Haemagglutination inhibition-HI and ND-ELISA), and also by field observation of the birds especially during the peak periods of outbreaks of Newcastle disease in the area (farmers response). Some of the vaccinated birds as well as the control were purchased for laboratory challenge with vilogenic field isolates of the Newcastle disease virus. Its Mean Death Time (MDT) in 10-days old chicken embryos was determined to be 36 hours, which confirmed its virulence. The vaccinated birds (with the ND I-2 and inactivated vaccines) as well as the controls were challenged intranasally with a drop of the virus suspension containing 10^6 $ELD_{50.}$ The birds were observed for any signs of Newcastle disease (swollen head, dullness, droopy wings, greenish diarrhoea) and where the birds died, they examined at necropsy for lesions characteristic of Newcastle disease (haemorrhages in the proventriculus, necrosis of the Peyers patches and caecal tonsil, haemorrhagic tracheitis, muscular haemorrhages). The virus was isolated from tissues (lungs, trachea, brain and spleen) and identified with Newcastle disease specific hyper immune serum in virus neutralization test in 10-days old chicken embryo.

RESULTS

In all 530 birds were wing tagged in each test group as well as the control group. Equal numbers of birds were bled from each group for serological monitoring of their immune responses to the vaccinations. The birds were also monitored through a buy-back challenge at the laboratory and also by field observation especially during the period peak outbreak of Newcastle disease in the areas.

Serological results

TABLE I. SEROLOGICAL RESULTS FROM HAEMAGGLUTINATION INHIBITION (HI) TEST.

No	Vaccine used	HI titres to Log base 2		
		0	3 weeks	6 weeks
1	I 2 eye drop	1.8	3.2	3.8
2	I-2 feather brushing	1.5	2.5	2.8
3	Inactivated	1.9	3.8	4.5
4	Controls	1.8	1.9	1.8

Field monitoring

Field monitoring was through interviews with farmers concerning the effect of Newcastle disease outbreaks in their communities after the intervention. In the villages where the chickens were vaccinated with the thermostable ND I-2 vaccine via the eye-drop route twice and the inactivated vaccine once, farmers were very happy with the results. There were no reported cases of Newcastle disease and they did not loss birds at all after the exercise. In the third village were the chickens were vaccinated with the ND I-2 by feather brushing of the eye, farmers said there were cases of Newcastle disease but the situation was not as devastating as the previous year. There was reportedly no difference in the Newcastle disease situation after the exercise as compared to the previous year in the control villages. They were even attributing the deaths of their flocks to our bleeding them and it took the provision of drugs to get them to accept the team back in the village.

Laboratory Challenge

Fifteen (15) birds were purchased from each group for a challenge at the Laboratory level with vilogenic field virus. The birds were observed for two weeks and the results were drawn after the last bird died and no other bird showed any clinical sign of disease. The results are shown in the Table II.

TABLE II. PROTECTION AFTER VELOGENIC ND-VIRUS CHALLENGE.

No.	VACCINE USED	Number Challenged	Number Dead	Number 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

From the table it can be seen that when the thermostable ND I-2 vaccine is administered via eye-drop route twice, it is equally effective as the inactivated vaccine in protecting rural chicken against virulent strains of the Newcastle disease virus.

A cost benefit analysis was estimated for the implementation of the intervention measure. The results showed that, a return of 13.8 was realized when the thermostable ND I-2 vaccine was used in the control of Newcastle disease administered via the eye drop as compared to a return of 10.5 with the inactivated vaccine. With the thermostable 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. The following tables clearly demonstrate this.

COST BENEFIT ANALYSIS

VACCINATION WITH THE ND I-2 VACCINE VIA EYE DROP ROUTE.

INCOME	COST
1.No.of birds vaccinated with NDI-2 vaccine by eye-drop = 530	1. Cost of I-2 vaccine for 530 birds @ ⊄20 per dose, 530 x ⊄20 = ⊄10,600
2. Survival due to vaccination (100%) from challenge results. = 530	2. Allowances for Vet Personnel for field trips = ⊄ 200,000.00
3.Survival last year after ND outbreak from epidata (20%) = 106	3. Transportation = ⊄ 200,000.00
4.Differential survival as a result of I-2 Vaccination by eye-drop, 530 – 106 = 424	4. Stationary = ⊄ 20,000.00
5. Income from I-2 vaccinated chicken, average price 15,000 cedis	5. TOTAL COST = ⊄ 430,000.00
424 x ⊄15,000=⊄ 6,360,000.00	6. PROFIT = INCOME- COST = ⊄ 5,929,400.00
	7. RETURNS = PROFIT ÷ COST = 13.8

VACCINATION WITH THE INACTIVATED VACCINE.

INCOME	COST
1.No. of birds vaccinated with the oil-adjuvant inactivated vaccine = 530	1. Cost of inactivated vaccine for 530 birds @ C250 per dose, 530 x C250 = C132,600.00
2.Survival due to vaccination (100%) from challenge results. = 530	2. Allowances for Vet Personnel for field trips = C 200,000.00
3.Survival last year after ND outbreak from epidata (20%) = 106	3. Transportation = C 200,000.00
4.Differential survival as a result of vaccination with inactivated vaccine 530 – 106 = 424	4. Stationary = C 20,000.00
5.Income from vaccinated chicken, average price C15,000 cedis	5. TOTAL COST = C 552,500.00
424 x C15,000=C 6,360,000.00	6. PROFIT = INCOME-COST = C 5,807,500.00
	7. RETURNS = PROFIT ÷ COST = 10.5

VACCINATION WITH THE ND I-2 VACCINE BY FEATHER BRUSHING OF THE EYE.

INCOME	COST
1.No. of birds vaccinated with I-2 vaccine by feather brushing = 530	1. Cost of I-2 vaccine for 530 birds @ ¢ 20 per dose, 530 x ¢20 = ¢10,600.00
2.Survival due to vaccination (80%) from challenge results. = 424	2. Allowances for Vet Personnel for field trips = ¢ 200,000.00
3.Survival last year after ND outbreak from epidata (20%) = 106	3. Transportation = ¢ 200,000.00
4.Differential survival as a result of I-2 vaccination by feather brushing, 424 – 106 = 318	4. Stationary = ¢ 20,000.00
5.Income from vaccinated chicken average price15,000 Cedis	5. TOTAL COST = ¢ 430,600.00
318 x C15,000=¢ 4,770,000.00	6. PROFIT = INCOME-COST = ¢ 4,339,400.00
	7. RETURNS = PROFIT ÷ COST = 10.1

VACCINATION WITH THE ND I-2 VACCINE BY FEATHER BRUSHING OF THE EYE WITH FARMERS DOING IT BY THEMSELVES.

INCOME	COST
1.No. of birds vaccinated with I-2 vaccine by feather brushing = 530	1. Cost of NDI-2 vaccine for 530 birds @ ¢20 per dose, 530 x ¢20 = ¢10,600.00
2.Survival due to vaccination (80%) from challenge results. = 424	2. Allowances for Vet Personnel for field trips = 0
3.Survival last year after ND outbreak from epidata (20%) = 106	3. Transportation for local Vet. to District center for vaccine. = ¢ 20,000.00
4.Differential survival as a result of I-2 vaccination by feather brushing 424 – 106 = 318	4. Stationary = 0
5.Income from vaccinated chicken C15,000 Ghanaian cedis per chicken	5. TOTAL COST = ¢30, 600.00
318 x C15, 000=¢ 4,770,000.00	6. PROFIT = INCOME-COST = ¢ 4,739,400.00
	7. RETURNS = PROFIT ÷ COST = 154.9

CONCLUSION

The thermostable (ND I-2) vaccine when administered via the eye drop route twice is equally effective as the oil-adjuvant inactivated vaccine in the control of Newcastle disease in rural chicken.

It however, has added advantages over the inactivated for being:

- 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 can thus be made readily available to farmers at their convenience
- Its application does not require specialized skills and farmers can administer the vaccine on their won.
- The returns from the usage of the thermostable I-2 vaccine with farmers administering it by themselves if enormous.

All these advantages will encourage patronage of the vaccine and lead to a much more wider vaccination coverage. The thermostable ND I-2 vaccine can therefore replace the inactivated vaccine for the protection of rural chickens against Newcastle disease.

STUDY II

THE EFFECT OF AN IMPROVED SUPPLEMENTARY FEEDING ON THE PRODUCTIVITY OF RURAL CHICKENS IN GHANA.

BACKGROUND.

The village level poultry production in Ghana and in Africa as a whole is based on free-rang scavenging systems, where the birds scavenge around for almost all of their nutritional requirements with little or no supplementary feeding. In the event where supplementary feeding is given it is usually made up of household leftovers or farm waste of very low nutritional value, which cannot cater adequately for the needs of the bird. The result is that even chicks are young as day old are left to wonder into the fields in search of feed and often fall victim to predators. The consequence is that, very few hatched chicks survive up to maturity.

The current study therefore seeks to demonstrate how an improved (nutritionally balanced feed ration) supplementary feeding of rural chickens help in ensuring chick survival, improve their growth rate and increase productivity in terms of numbers of eggs laid per clutch, fertility and hatchability.

MATERIALS AND METHODS.

The main material in this study is a commercial well-balanced feed (chick starter and Grower feed) from a recognized feed mill. The other materials used included Electronic weighing scales, plastic polythene bags for the distribution of measured quantities of the feed, daily record books.

The study was carried out in the two ecological zones (Coastal and Forest) participating in the farmyard poultry project. In each of these zones, two villages were chosen as the test sites with a third being the control. In a test site, four women farmer with rural chickens were contacted and briefed on the study procedure. A number of day old chicks were selected from each woman farmer and monitored over a period of six months spanning across the wet and dry seasons of the year.

The supplementary feeding study targeted chicks from day old, and monitored for their survival, growth rate, and maturity over a six months period. Since the study is on supplementary feeding under the rural chicken production system and not under total intensive system, the chickens were fed adequately but allowed to scavenge as well. However, chicks in the test sites were confined until they are two week old and capable of avoiding predation before allowed to free-range. The chicks in the control group were allowed to undergo their usual husbandry practice, which is scavenge around as from day old.

The chicks in the test group are given a measured amount of feed to last for a fortnight. The quantity consumed over this period is estimated after weighing the leftovers. The chicks are then weighed at the same two weeks interval and observed closely for the development of feathers, growth rate, and other signs of good development. The chicks in the control village in both zones are also weighed at the same time intervals.

Alongside the supplementary feeding study, all the rural chickens in all of the villages of both zones were vaccinated against Newcastle disease using the thermostable (ND I-2) vaccine produced locally. The trained village vaccinators willingly administered the vaccine. It is important to note here that the continuing vaccination of the chickens against Newcastle disease with the thermostable vaccine has had good result and this greatly encouraged farmers to fully embrace the current study. It was noted that fowl pox was a major problem being responsible for the losses of great numbers of chicks. The flocks were therefore routinely vaccinated in all villages together with the control of endo and ecto parasites. The only varying parameter was the provision of supplementary feed.

RESULTS.

The control of Newcastle disease through the use of the thermostable ND I-2 vaccine, with the farmers now vaccinating their own flocks has had immense impact. The flock sizes of the households have greatly increased and a number of hens incubating eggs could easily be seen in all households. An indication of an improving farmyard poultry production.

Table I shows the flocks of household at the beginning of this study.

TABLE I. FLOCK SIZES AT BEGIN OF STUDY.

Zone	Village	Household	Flock size		
			Chickens	Ducks	Turkeys
Coastal	Adentan	Janet Addo	79	40	0
		M. Amenyaw	65	0	0
		Martina Youri	53	15	0
		Matilda Nobia	115	0	0
	Amanfro	Felicia Annan	131	0	32
		A. Davordzie	71	0	0
		Lydia Adabah	57	0	0
		E.Hammon	68	0	0
	La	C.Asampana	212	0	0
		Mabel Apen	93	0	0
		G. A. Boye	69	0	0

		Philis Sackey	74	0	0
Forest	Odankwah	J. Dankwah	103	0	0
		A.Achaempong	69	0	0
		Comfort Badu	75	0	0
		Hanna Quaye	82	0	0
	Okwabena	A. Adjo Dai	143	40	16
		Mary Abeka	12	29	0
		Juliana Quaye	113	0	0
		Comfort Tetteh	96	0	0
	Otopease	E. Yamoah	135	0	0
		Afua Otoo	79	23	0
		Ama Kumah	118	0	0
		Regina Essiah	95	0	0
		TOTAL	2207	147	48

TABLE II. NUMBER OF CHICKS IN THE VARIOUS HOUSEHOLDS.

ZONE	VILLAGE	HOUSEHOLD	GROUP	No of Chicks
COASTAL	LA	C.Asampana	TEST	18
		Mabel Apen		15
		Gertrude A. Boye		17
		Philis Sackey		10
	ADENTAN	Janet Addo	TEST	12
		M.Amenyaw		17
		Martina Youri		10
		Matilda Nobia		16
		TOTAL		115
	AMANFRO	Felicia Annan	CONTROL	20
		Alica davordzie		17
		Lydia Adabah		15
		Emelia Hammon		18
		TOTAL		70
FOREST	OKWABENA	Adjoa Adjo Dai	TEST	25
		Mary Abeka		19
		Juliana Quaye		24
		Comfort Tetteh		17
	OTOPEASE	E.Yamoah	TEST	17
		Afua Otoo		20
		Ama Kumah		19
		Regina Essiah		15
		TOTAL		156
	ODANKWAH	Joanna Dankwah	CONTROL	18
		A.Achaempong		18
		Comfort Badu		22
		Hanna Quaye		16
		TOTAL		74

The chicks together with the brooding hens were supplemented daily with a compounded poultry balanced ration. Chicks were given chick starter ration from day old to three months of age and a Grower feed from three months to six months of age. Table III shows the composition of the feed rations used.

TABLE III. FEED COMPOSITION.

No	COMPOSITION	CHICK STARTER	GROWER FEED
1	Metabolisable Energy Kcal / kg of feed	2700	2600
2	Crude protein %	18–19	15
3	Fiber %	23	27
4	Amino acids		
	Methionine %	0.5	0.35
	Lysine %	1.0	0.7
5	Mineral salts		
	Calcium %	1.0	1.10
	Phosph. %	0.48	0.4
	Sodium %	0.17	0.10

At every visit, all the chicks in both the Test and Control Groups are weighed, and as the chicks were tagged for identification, the average weight of the chicks in each household was recorded. From this, the weight gained of the chicks in the test groups that can be attributed to the intervention is estimated by subtracting the weight of the control chicks.

The Table IV below compares of the weight gain (growth rate) of the chicks receiving supplementary feeding and those without, on Zonal basis.

TABLE IV. GROWTH RATE COMPARED FOR FEED SUPPLEMTATION.

No.	Zone	Weight gain in gram in a fortnight												
		0	1	2	3	4	5	6	7	8	9	10	11	12
1	Coastal Test gp	21	32	57	77	91	109	144	193	225	261	306	371	434
2	Coastal Control	22	30	47	56	66	84	96	99	110	127	187	226	249
3	Forest Test gp.	22	31	59	81	100	129	170	208	229	273	312	386	449
4	Forest Control	22	31	50	58	70	82	91	99	118	132	192	236	258

From the table it is clearly visible that with supplementary feeding the chick grow much more rapidly than without more than doubling the weight of the latter by the end of the sixth month. They were fully grown pullets ready for laying. Also, apart from a few chicks in the test group that died from infections with fowl pox, the survival rate of the chicks was an overall of 85% (230 out of 271 chicks survived to the sixth month) as compared a survival rate of 53 % for the control group (76 out of 144 chicks surviving up the end of the study). Most of the chicks were lost in the first two to four weeks of age to predation (rain, snakes, hawks and Road accidents).

It was noticed that at the age of two weeks when the chicks in the test groups were allowed to scavenge around with the brooding hens, they had grown secondary feathers and were relatively active to avoid predation to some extent. In three months the chicks, receiving supplementary feed in both zones had gained almost 200 grams, which to a rural chicken is a significant growth.

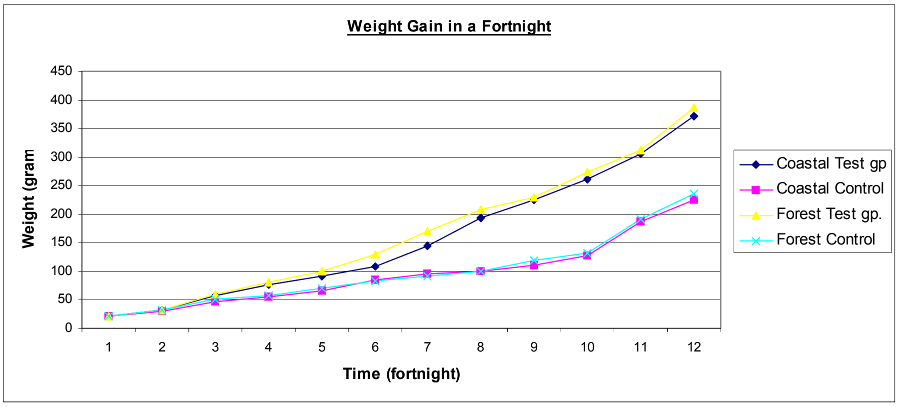

FIG. 1. Difference in weight gain between the chicks supplemented with balance ration as compared to the control group in both zones.

Table V illustrates the weight gain because of the supplementary feeding, which is the difference of the weight gain of the test group chicks against that of the control chicks, on Zonal basis.

TABLE V. WEIGHT GAIN.

No.	Zone	Differential weight (gm) gain in a fortnight												
		0	1	2	3	4	5	6	7	8	9	10	11	12
1	Coastal	0	2	10	21	25	25	48	94	115	134	119	135	185
2	Forest	0	0	9	23	30	47	79	109	111	141	120	150	191

From the results it can be seen that there is no significant difference in weight gain by the chicks in the Forest Zone as compared to those in the Coastal Zone. The controls in both zones has very much compensated for any breed differences, since same breeds of rural chickens are found in the same zone.

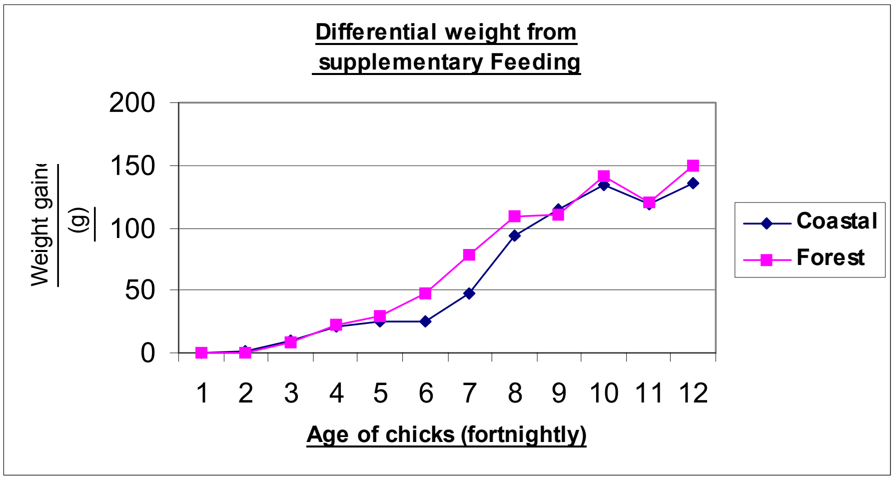

FIG. 2. Differential weight gained by the chicks receiving the supplementary Feeding in the Zones.

TABLE VI. DAILY SUPPLEMENTARY FEED CONSUMPTION AVERAGED PER CHICK.

No.	Zone	Feed Consumption per chick per day in gram												
		0	1	2	3	4	5	6	7	8	9	10	11	12
1	Coastal	0	8	10	17	27	32	33	36	38	40	42	44	45
2	Forest	0	8	8	16	24	28	30	33	36	38	41	42	42

Comparing the feed consumption to the growth rate, a relatively high feed conversion can be seen. However, it is important to note here that, the growth is also in part to the rich Scavenging Feed Resource base (SFRB). The supplemented birds mature faster and are more capable to scavenge around.

TABLE VII. SUPPLEMENTARY FEED CONSUMPTION AVERAGED PER CHICK IN A FORTNIGHT.

No.	Zone	Feed Consumption per chick fortnightly (grams)												
		0	1	2	3	4	5	6	7	8	9	10	11	12
1	Coastal	0	112	140	238	378	448	462	504	532	560	588	616	630
2	Forest	0	112	112	224	336	392	420	462	504	532	574	588	588

TABLE VIII. FEED CONVERSION RATE OF THE CHICKS RECEIVING SUPPLEMENTARY FEEDING IN BOTH ZONES.

No.	Zone	Feed conversion rate (%)												
		0	1	2	3	4	5	6	7	8	9	10	11	12
1	Coastal	0	1.8	7.2	8.8	6.6	5.5	10.4	18.7	21.6	23.9	20.2	21.9	29.4
2	Forest	0	0	8.0	10.3	8.9	12.0	18.8	23.6	22.0	26.5	20.1	25.5	32.5

$$\text{Feed Conversion Rate} = \frac{\text{Weight gained within time period} \times 100}{\text{Feed consumed within the same time}} \ (\%)$$

The feed conversion rate slows down during the dry season (around the 9th to the 12th fortnight). The chicks in the Forest Zone seem to have a relatively much higher feed conversion rate. This can be attributed to the availability of a richer Scavenging Feed Resource Base (SFRB) in the forest. The supplemented chicks, which mature relatively faster than the un-supplemented one, are more capable to scavenge and hence gain more weight with little intake of the supplemented feed.

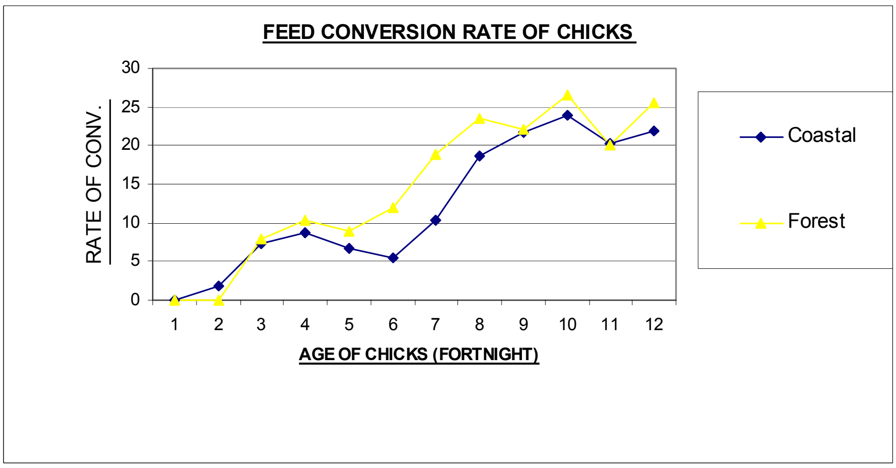

FIG. 3, Feed conversion rate of the chicks in the 2 Zones. There is no significant difference between the two groups.

TABLE IX. COST-BENEFIT ANALYSIS OF THE SUPPLEMENTARY FEEDING.

INCOME	COST
1. Differential survival of chicks as a result of the intervention from the total of 271 receiving supplementation: – – 85 % survival with feed (230) – 53 % survival without feed (143) – difference (230–142 = 87) these birds will only count as income 87 x C 35,000.00 = ¢ 3, 045,000.00	1. FEED COST 1 bag of Chick Starter feed ¢ 95,000.00 1 bag of chick Grower feed ¢ 80,000.00 Total cost of Feed ¢ 175,000.00
2 Differential weight gain (190gm) survival due to supplementary feeding is 87.	2. Stationary cost ¢ 20,000.00
Total weight gain 87 x 190gm = 16,530 Assuming cost price of C 45,000 pre kg of live weight of chicken Total income C 45,000 x 16.530 = ¢ 743,850.00	3. Small allowances for field officers to supervising feeding of chicks in both zones @ ¢ 20,000.00 / month for six months = 2x 6 x ¢ 20,000.00 = ¢ 240,000.00
5. Income	5. TOTAL COST = ¢ 435,000.00
¢ 3, 788,850.00	6. PROFIT = INCOME-COST = ¢ 3,353,850.00 7. RETURNS = PROFIT ÷ COST = 7.7

CONCLUSION

Supplementary feeding of rural chickens significantly helps in chick survival (85% as against 53% without). Within a period of six months, birds receiving supplementary feed gain an average weight difference of up 190 grams, and are much more matured and ready to lay. Early laying will definitely increase the number of eggs per hen per because the rural chicken will now have a higher of clutches per year. Well fed incubating hens in an environment without the threat of ecto parasite infestations will better sit on eggs ensuring a good hatchability. This means an increase in productivity.

The cost: benefit analysis estimated on only weight gain and chick survival gives a net return of 7.7 with supplementary feeding. This is even without the long term benefits such as increased number of eggs laid, increased fertility since both the laying hens and cocks are well nourished, fertile will definitely increase, as well as the expected increased hatchability.

DISCUSSION

The two studies have clearly shown that rural poultry production can be improved when both health and husbandry issues are improved simultaneously.

On health issues, Newcastle disease among rural chickens can be controlled effectively with the use of the thermostable ND I-2 vaccine administered via the eye drop route. Since new chicks are hatched almost every two to three months, a vaccine regime every quarter of the year will ensure that these newly hatched chicks are protected against the sporadic outbreaks of the disease throughout the year. With an effective control of the Newcastle disease in place, the second most important disease is fowl pox, especially among chicks. There are very potent 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 incubating hens. Sulfur based insecto-acaricides are effective in controlling them.

On husbandry issues, a well-balanced and sufficient supplementary feeding is vital in an attempt to improve the productivity of rural poultry. In the early days of the life of the chicks, supplementary feeding greatly helps in their survival, improves their growth rate and by the time they free-range, they are more capable of scavenging. The birds mature faster and get into lay much earlier.

In Ghana, the Government is fighting hard to eradicate poverty by the year 2020. Rural chicken production, which is practiced in almost all the rural communities and the peri-urban areas, is a sure way to ensure family food security and reduce poverty. A holistic approach to the improvement of the rural chicken production is imperative, focusing on the improvement of the health and husbandry practices.

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COMPARATIVE ADVANTAGE OF THE USE OF A THERMOSTABLE VACCINE IN THE PROTECTION OF RURAL CHICKENS AGAINST NEWCASTLE DIEASE IN GHANA

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Abstract

Rural poultry production systems in Ghana and in Africa as a whole face a number of both health and husbandry problems which greatly limit their improvement. In the survey carried out earlier to highlight these problems, Newcastle disease (ND) was acknowledged as the major constraint. Other constraints included diseases such as fowl pox, endo- and ecto-parasites. 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 to compare the effectiveness of a thermostable, 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 (three weeks apart) via eye drop was found to be equally 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.

For many years, the oil-adjuvant inactivated vaccine has been used 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 represents one of the methodologies used by African farmers to generate income in increase access to animal protein. It offers the best yield in converting vegetable calories into high yield animal protein. Village poultry production is widely practiced in Africa especially among rural communities. The Village poultry production systems of Africa are mainly based on the scavenging indigenous chicken found in virtually all villages and households. These systems are characterized by a low or no input supply in terms of feed and medications, and low productivity. Nevertheless, over 70 percent of the poultry products and 20 percent of animal protein intake in most African countries come from village poultry. Therefore, increasing rural poultry production would result in a positive impact on household food security both in increased dietary intake and income generation [2].

However, it is sad to note that rural poultry is not rated highly in the mainstream of 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 with relatively high mortality rates [3, 4]. Especially young chicks die in large numbers. Several reasons for this high mortality and low productivity have been suggested, such as sub optimal management, malnutrition, predation, disease, and poor quality if any of supplementary feeding [5, 6, 7, 8, 9].

Among the diseases affecting rural poultry, 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 percent of household poultry annually [5, 8, 10, 11, 12, 13]. Other diseases such as fowl pox, colibacillosis, endo- and ecto-parasites 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 potentials of the rural chicken.

In Ghana, the Government is fighting hard to eradicate poverty by the year 2020. Rural chicken production, which is practiced in almost all the rural communities and the peri-urban areas, is a sure way to ensure family food security and reduce poverty. A holistic approach to the improvement of the 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. This has been due to the fact that 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 thermostable I-2 ND vaccine in to the country was seen as a way to overcome these problems. The aim of the study was therefore to compare the effectiveness of the thermostable I-2 ND vaccine, which is being produced locally, and an oil-adjuvant vaccine in the protection of rural chickens against challenge with virulent ND virus strains, with the view to replacing the latter with the former should results support such a change.

MATERIALS AND METHODS

The materials used for the study were:

- Thermostable I-2 ND vaccine produced locally from the master seed provided by the John Francis Veterinary Laboratory, Department of Virology, University of Queensland, AUSTRALIA.
- Oil-adjuvant inactivated ND vaccine for parental administration, virus strain Brescia > 108ELD50, Institute Zooprofilactico, distributed by CHEMNI DE LA MILLETIRE, BP 7562, 37073, TOURS, CEDEX 2, FRANCE, Batch No. 2518
- Velogenic field strain of the ND virus, isolated at the Accra Veterinary Laboratory, in 10-days old chicken embryo, with a Mean Embryo Death Time (MDT) of 36 hours.
- Eye drop applicator for the administration of the thermostable I-2 ND vaccine calibrated to deliver 10 µl of vaccine dose per drop.
- Chicken feather stripped to carry 10 µl 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 these zones, four villages were selected for the study. In each ecological zone, the rural chickens of four female farmers in one village were wing tagged and vaccinated against ND using thermostable I-2 ND vaccine via eye drop twice at an interval of three weeks. In a second village the vaccine was administered by brushing eye with a calibrated feather tip twice at the same interval of three weeks. Chickens in a third village were vaccinated with the oil-adjuvant inactivated vaccine by subcutaneous injection only once as per normal practice. The fourth village was left as a control with the chickens not vaccinated at all.

A total of 530 birds were wing-tagged in the test (experimental) and control groups. 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, and before the second vaccination with I-2 ND vaccine and three weeks post 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 [14] and ND-ELISA, kit supplied by IAEA), and by field observation of the birds especially during the peak periods of outbreaks of ND in the area (farmers' response). Some of the vaccinated birds as well as some of the controls (15 birds per experimental group) were purchased for laboratory challenge with velogenic field isolates of the ND virus. The Mean Death Time (MDT) of the challenge strain of ND virus in 10-day old chicken embryos was determined to be 36 hours; indicating that it is a velogenic strain of ND. 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 ELD_{50}. The birds were observed for any signs of ND (swollen head, dullness, droopy wings, greenish diarrhoea) and dead birds examined at necropsy for lesions characteristic of ND (haemorrhages in the proventriculus, necrosis of the Peyers patches and caecal tonsil, haemorrhagic tracheitis, muscular haemorrhages). The virus was isolated from tissues (lungs, trachea, brain and spleen) and identified with ND specific hyper immune serum in virus neutralization test in 10-day old chicken embryo.

A cost benefit analysis was performed using the partial budget method to evaluate effectiveness of each type of vaccine used.

RESULTS

Serological Results

The serological results from Haemagglutination Inhibition (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 I).

TABLE I. GEOMETRIC MEAN HI-TITRES FOR EACH EXPERIMENTAL GROUP AT 0, 3 AND 6 WEEKS POST 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

Field monitoring of vaccinated birds

Interviews with farmers were used to evaluate the effect of ND outbreaks in their communities after the intervention. 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 reported cases of ND and they did not loose birds at all 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. They were even attributing the deaths of their flocks to our blood sampling and it took the provision of drugs to convince them to accept the team back in the village.

Laboratory Challenge

Fifteen birds were purchased from each experimental group for challenge at the Laboratory with a velogenic field ND virus. The birds were observed for two weeks after being challenged with field virus. The results were collected after the last bird died and no other bird showed any clinical sign of disease. The results are shown in Table II.

TABLE II. RESULTS OF CHALLENGE WITH VELOGENIC FIELD ND VIRUS.

No.	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

The results show that when the thermostable I-2 ND vaccine is administered via eye drop twice, it is equally effective as the inactivated vaccine in protecting rural chickens against virulent strains of the ND virus (Table II)

Cost benefit analysis

A cost benefit analysis was estimated for the implementation of each intervention. The results showed that, a return of 13.8 was obtained when the thermostable 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 thermostable 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 (III,IV,V,VI) clearly demonstrate this.

TABLE III. VACCINATION WITH I-2 ND VACCINE VIA EYE DROP.

INCOME	VALUE	COST	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 x ¢20 =	¢10,600
2. Survival due to vaccination (100%) from challenge results. =	530	2. Allowances for Vet Personnel for field trips =	¢ 200,000
3. Survival last year after ND outbreak from epidata (20%) =	106	3. Transportation =	¢ 200,000
4. Differential survival as a result of I-2 vaccination via eye-drop, ¢530 – ¢106 =	424	4. Stationary =	¢ 20,000
5. Income from I-2 vaccination via eye-drop, considering average price of a village chicken to be ¢15,000 Ghanaian Cedis per chicken 424 x ¢15,000 =¢6,360,000		5. TOTAL COST =	¢ 430,000
		6. PROFIT = (INCOME-COST)	¢ 5,929,400
		7. RETURNS = (PROFIT ÷ COST) =	13.8

TABLE IV. VACCINATION WITH THE INACTIVATED ND VACCINE.

INCOME	VALUE	COST	VALUE
1. No. of birds vaccinated with the oil-adjuvant inactivated vaccine =	530	1. Inactivated vaccine for 530 birds @ ¢250 per dose, 530 x ¢250 =	¢132,600
2. Survival due to vaccination (100%) from challenge results. =	530	2. Allowances for Vet Personnel for field trips =	¢200,000
3. Survival last year after ND outbreak from epidata (20%) =	106	3. Transportation =	¢200,000
4. Differential survival as a result of vaccination with inactivated vaccine 530 – 106 =	424	4. Stationary =	¢20,000
5. Income from vaccinated chicken; ¢15,000 Ghanaian Cedis per chicken 424 x ¢15,000 =	¢6,360,000	5. TOTAL COST =	¢552,500
		6. PROFIT = (INCOME-COST)	¢5,807,50
		7. RETURNS = (PROFIT ÷ COST) =	10.5

TABLE V. VACCINATION WITH I-2 ND VACCINE BY FEATHER BRUSHING OF THE EYE.

INCOME	VALUE	COST	VALUE
1. No. of birds vaccinated with I-2 ND vaccine administered via feather brushing of the eye =	530	1. Cost of inactivated vaccine for 530 birds @ ¢20 per dose, 530 x ¢20 =	¢10,600
2. Survival due to vaccination (80%) from challenge results. =	424	2. Allowances for Vet Personnel for field trips =	¢200,000
3. Survival last year after ND outbreak from epidata (20%) =	106	3. Transportation =	¢200,000
4. Differential survival as a result of vaccination with inactivated vaccine 424 – 106 =	318	4. Stationary =	¢20,000
5. Income from vaccinated chicken ¢15,000 Ghanaian Cedis per chicken 318 x ¢15,000 =	¢4,770,000	5. TOTAL COST =	¢430,600
		6. PROFIT = (INCOME-COST) =	¢4,339,400
		7. RETURNS = (PROFIT ÷ COST) =	10.1

TABLE VI. VACCINATION WITH I-2 ND VACCINE BY FEATHER BRUSHING OF THE EYE PERFORMED BY FARMERS THEMSELVES.

INCOME	VALUE	COST	VALUE
1. No. of birds vaccinated with I-2 ND vaccine administered via feather brushing of the eye =	530	1. Cost of inactivated vaccine for 530 birds @ ¢20 per dose, 530 x ¢20 =	¢10,600
2. Survival due to vaccination (800%) from challenge results. =	424	2. Allowances for Vet Personnel for field trips =	¢0
3. Survival last year after ND outbreak from epidata (20%) =	106	3. Transportation =	¢20,000
4. Differential survival as a result of vaccination with inactivated vaccine 424 – 106 =	318	4. Stationary =	¢0
5. Income from vaccinated chicken ¢15,000 Ghanaian Cedis per chicken 318 x ¢15,000 =	¢4,770,000	5. TOTAL COST =	¢30,600
		6. PROFIT = (INCOME-COST) =	¢4,739,400
		7. RETURNS = (PROFIT ÷ COST) =	154.9

DISCUSSION

The thermostable, live I-2 ND vaccine when administered via eye drop twice is equally as effective as the oil-adjuvant inactivated vaccine in the control of ND in rural chicken.

Furthermore, it has added advantages over the inactivated for being:

- 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 can thus be made readily available to farmers at their convenience
- Its application does not require specialized skills and farmers can administer the vaccine on their own.
- The return from the usage of thermostable I-2 ND vaccine when farmers administer it by themselves is very high.

All these advantages will encourage patronage of the I-2 ND vaccine and lead to much wider vaccination coverage. The thermostable, 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 two to three months, revaccination of chickens at three-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 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. Sulphur based insecto-acaricides are effective in controlling them.

CONCLUSION

This study has clearly shown that rural poultry production can be improved when locally produced ND I-2 vaccine is used to control ND.

The results showed that, a return of 13.8 was obtained when thermostable 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 injectable inactivated vaccine. With the thermostable, 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.

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AMELIORATION DE LA PRODUCTION EN AVICULTURE FAMILIALE: CAS DE LA CÔTE D'IVOIRE

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Abstract

Family poultry production without any care carries many constraints which lead to loss of birds. Through the FAO/IAEA Coordinated Research Project (CRP) on: « Assessment of the effectiveness of vaccination strategies against Newcastle disease and Gumboro disease using immunoassay-based technologies for increasing farmyard poultry production in Africa», we implemented some interventions in family poultry production in 3 working groups to assess the improvement of the productivity compared to a situation without interventions. In group 1: birds are vaccinated against Newcastle disease and had parasitic treatment. In group 2: birds are vaccinated, had parasitic treatment and had supplementary feeding. In group 3: birds are vaccinated, had parasitic treatment, had supplementary feeding and chicks are protected against predators. These interventions showed that the best programme for the farmers is the one of group 3, which resulted in: a low rate of mortality due to vaccination and parasitic treatment, the improvement of performance of body weight due to supplementary feeding, and the increase in number of chickens in livestock due to the protection of chicks against predators.

INTRODUCTION

L'aviculture familiale se caractérise par un élevage de volailles en divagation sans soins particuliers. Elle connaît une productivité très faible et un manque à gagner important pour les éleveurs, compte tenu de nombreuses contraintes qui s'imposent à elle, à savoir : Une forte mortalité due aux infestations parasitaires et à la maladie de Newcastle, une alimentation déséquilibrée, des pertes dues aux prédateurs. Nous avons pu confirmer l'existence de ces contraintes par les activités menées de 1999 à 2000 à travers le projet de recherche coordonné (CRP) de l'AIEA intitulé : « Assessment of the effectiveness of vaccination strategies against Newcastle disease and Gumboro Disease using immunoassay-based technologies for increasing farmyard poultry production in Africa ». La première étape de ces activités a porté sur des enquêtes épidémiologiques et la réalisation d'un bilan sanitaire. Ces enquêtes ont montré la description de maladie avec des signes cliniques évoquant la maladie de Newcastle. Le bilan de la coprologie faisait état d'une forte infestation parasitaire. Donc nous avons déduit qu'une bonne maîtrise de ces contraintes majeures permettra d'améliorer la productivité de l'aviculture familiale. La deuxième étape nous a amené à entreprendre des interventions depuis l'année 2000 dans le but d'améliorer cette productivité. D'abord, nous avons effectué le déparasitage des volailles, puis des vaccinations contre la maladie de Newcastle, suivies de l'évaluation de l'efficacité de cette vaccination par l'utilisation de la technique ELISA. Les résultats obtenus ont montré un taux de protection des animaux de plus de 80% [4].

Une fois la situation sanitaire améliorée, il est important de poursuivre le programme d'amélioration de la productivité par la mise en place de l'apport de supplément alimentaire et la protection des poussins contre les prédateurs. Ceci a constitué la 3ème phase de notre travail.

Pour évaluer l'impact réel de ces interventions du point de vue économique par rapport à une situation sans interventions, il apparaît nécessaire de constituer des groupes d'élevages avec des variantes à étudier afin de déterminer le type d'élevage qui soit le plus rentable pour l'éleveur.

- Groupe 1 : animaux vaccinés et déparasités
- Groupe 2 : animaux vaccinés, déparasités et supplémentés
- Groupe 3 : animaux vaccinés, déparasités, supplémentés avec existence de poulailler pour la protection des poussins jusqu'à 3 mois d'âge contre les prédateurs

MATERIELS ET METHODES

Choix des élevages visités

Le choix des élevages visités s'est fait de façon aléatoire dans un périmètre de 100 km autour de la ville d'Abidjan. Deux zones (zone 1: Adzopé et zone 2: Agboville) distantes de 50 km ont servi de base pour le choix des élevages. Ces élevages sont répartis dans trois groupes d'étude.

- Groupe 1: constitué de 2 élevages dans la zone d'Adzopé et de 3 élevages dans la zone d'Agboville; animaux vaccinés et déparasités
- Groupe 2: constitué de 4 élevages dans la zone d'Adzopé et de 4 élevages dans la zone d'Agboville; animaux vaccinés, déparasités et supplémentés
- Groupe 3: constitué de 1 élevage dans la zone d'Agboville; animaux vaccinés, déparasités, supplémentés et protection des poussins contre les prédateurs

Travaux effectués

Calendrier des visites :

Période 1: période sans intervention sur les volailles: septembre 2002 à avril 2003

- 11 au 12 septembre 2002 : prise de contact avec les éleveurs et recensement des poulets.

Période 2: période d'intervention sur les volailles: juin 2003 à janvier 2004

- 18 au 19 juin 2003 : recensement des poulets, déparasitage interne et externe des poulets, marquage individuel des poulets avec des bagues et pesée des poulets avant l'apport de supplément alimentaire.
- 25 au 26 août 2003 : recensement des poulets, pesée des poulets, mise en place de la supplémentation alimentaire dans les élevages sélectionnés.
- 29 au 30 septembre : recensement et pesée des poulets.
- 22 octobre 2003 : recensement et pesée des poulets.
- 26 novembre et 17 décembre 2003 : recensement des poulets, vaccination contre la maladie de Newcastle, déparasitage interne et pesée des poulets.
- 28 janvier 2003 : recensement et pesée des poulets, vaccination contre la maladie de Newcastle et déparasitage interne du groupe 3.

Description des détails des travaux effectués

Recensement des animaux

A chaque visite, les poulets sont comptés par classe d'âge et par sexe chez les adultes. Les paramètres liés à l'augmentation ou à la diminution de la productivité sont enregistrés.

Pesée des animaux :

A chaque visite, les adultes et les jeunes sont individuellement pesés alors que les poussins sont pesés par lot de 5 ou 10 animaux.

Vaccination :

Tous les animaux âgés de plus de 1 mois d'âge, ont été vaccinés avec le vaccin inactivé ITA-NEW du laboratoire LAPROVET à la dose de 0,5 ml par animal par voie intramusculaire. Les poussins de moins de 1 mois d'âge ont été vaccinés avec le vaccin Hitchner B1du laboratoire INTERVET par voie oculaire.

Déparasitage des animaux

Compte tenu des fortes infestations parasitaires notées au cours des enquêtes épidémiologiques et des bilans parasitaires déjà établit [3], les volailles ont été déparasitées avec le vermifuge polyvalent des volailles (V.P.V) du laboratoire LAPROVET à la dose de 1 comprimé pour 2kg de poids vif. Quant au déparasitage externe, il a été effectué avec le carbaryl (sepou) du laboratoire coophavet.

Apport de supplément alimentaire

Le supplément d'aliment est constitué de son de blé, de grains de maïs concassés, de farine de poisson séché et des coquillages broyés. Le mélange suivant est réalisé: 50 kg de son de blé + 25 kg de maïs + 2 kg de coquillages broyés + 1 kg de farine de poisson séché. Dans les élevages concernés, la ration journalière du supplément d'aliment par animal était de 40g du mélange pour les jeunes et les adultes, et de 10g pour les poussins.

Protection des poussins contre les prédateurs

Un seul élevage disposant d'un poulailler convenable dans la région d'Agboville a été sélectionné pour la protection des poussins contre les prédateurs : la poussinière est cloisonnée en trois compartiments pour le maintien des poussins à différends âges : de 2 semaines à 1 mois, de 1 à 2 mois et de 2 à 3 mois. Puis après 3 mois d'âge, ils sont laissés en divagation. Les poussins sont conservés avec la mère poule les deux premières semaines dans un local à part. Ils sont nourris avec l'aliment de la supplémentation et sont chauffés au charbon de bois conservé dans un récipient métallique. Les mangeoires et les abreuvoirs sont en matériel local (bambou).

Méthode économique

La méthode utilisée pour l'analyse économique est celle préconisée par W. GOODGER [5]

- Différence en revenus = prix de vente des poulets après les interventions - prix de vente des poulets avant les interventions
- Bénéfice = Différence en revenus – dépenses engendrées par les interventions
- Rendement = Différence en revenus / dépenses engendrées par les interventions

RESULTATS

Recensements des animaux

Le recensement a permis d'avoir le nombre total d'animaux dans chaque groupe, au début et à la fin de chaque période (voir tableau I); Il a permis de connaître aussi les paramètres liés à l'augmentation ou à la diminution de la productivité. Durant l'exécution du projet de recherche, nous avons noté que la performance des poules était de 30 œufs en moyenne par poule et par an. Dans tous les élevages visités, la majorité des œufs pondus sont laissés à la disposition des poules pour la couvaison. Le taux d'éclosion est de 80% en moyenne. Les causes et les taux de mortalités des volailles décrits pour la période 1 (sans interventions) sont les mêmes que ceux des enquêtes épidémiologiques de la première phase du travail [3]. Les plus importantes causes de pertes au cours de la période 2 sont les prédateurs au niveau des poussins avec un taux de 50% dans le groupe 1 et de 40% dans le groupe 2. On note aussi quelques cas de variole, de maladies respiratoires et des cas de vol d'animaux adultes dans le groupe 1 et 2 (voir tableau II). Ainsi nous avons pu noter à la fin de chaque période le nombre total d'animaux constituant un capital de revenu pour chaque éleveur. Ce capital inclus les animaux vendus, consommés ou donnés à d'autres personnes et ceux existant sur pied dans l'élevage.

TABLEAU I. RECENSEMENT DES POULETS PAR GROUPE ET PAR PERIODE.

Période	Groupe/ début et fin de chaque période		poussins	jeunes	poules	coqs	Total
Période1 sans intervention	n°1	Sep 2002	37	34	33	8	112
		Avril 2003	20	8	16	4	48
	n°2	Sep 2002	55	46	77	16	194
		Avril 2003	25	14	20	8	67
	n°3	Sep 2002	9	5	21	2	37
		Avril 2003	0	0	2	1	3
Période2 avec intervention	n°1	Juin 2003	18	8	16	2	44
		Janv. 2004	26	26	26	5	83
	n°2	Juin 2003	83	89	70	25	267
		Janv. 2004	91	60	113	43	307
	n°3	Juin 2003	0	0	2	1	3
		Janv. 2004	25	7	8	3	43

TABLEAU II. CAUSES ET TAUX DE PERTES AU COURS DE LA PERIODE G = GROUPE 2.

Causes	poussins			Jeunes (de 2 à 3 mois)			Jeunes (plus de 3 mois) et adultes		
	G1	G2	G3	G1	G2	G3	G1	G2	G3
Maladie de Newcastle	0%	0%	0%	0%	0%	0%	0%	0%	0%
Variole	10%	15%	0%	5%	2%	0%	0%	0%	0%
Maladies respiratoires	5%	3%	10%	5%	3%	0%	0%	0%	0%
Prédateurs	50%	40%	0%	10%	10%	0%	0%	0%	0%
Accidents	5%	2%	0%	0%	0%	0%	0%	0%	0%
vol	0%	0%	0%	0%	0%	0%	(15%)	(5%)	0%
% des pertes	70%	60%	10%	20%	15%	0%	15%	5%	0%
% de survie	30%	40%	90%	80%	85%	100%	85%	95%	100%

Incidence de l'apport de supplément alimentaire

Les pesées effectuées avant et après la mise en place de la supplémentation alimentaire nous ont donné les valeurs suivantes :

Avant l'apport de supplément alimentaire et dans le groupe des animaux non supplémentés, nous avons un gain de poids mensuel de : 100g pour les poules, 0g à 50g pour les coqs, 150g pour les jeunes (coquelets et poulettes), 20g pour les poussins.

Après l'apport de supplément alimentaire, nous avons un gain de poids mensuel de : 300g pour les poules et jusqu'à 500g pour certaines poules en ponte, 200g pour les coqs, 300g pour les jeunes (coquelets et poulettes), 50g pour les poussins.

Incidence de la protection des poussins contre les prédateurs

La survie des poussins au cours de la période 2 est de 30% dans le groupe 1, de 40% dans le groupe 2, et de 90% dans le groupe 3 où les poussins sont protégés contre les prédateurs jusqu'à 3 mois d'âge. (voir tableau n°2)

Statistique économique

Afin de s'apercevoir de l'efficacité du suivi du programme d'amélioration de l'aviculture familiale, il est utile de connaître les frais engendrés et les bénéfices par rapport à la situation sans soins particuliers.

Estimation des dépenses engendrées par l'application du programme d'amélioration au cours de la période n°2 :

Les dépenses engendrées prennent en compte, le coût des vaccins, le coût estimatif de l'administration des vaccins, les traitements anti-parasitaires et le coût du supplément alimentaire.

La dose du vaccin Itanew est estimée à 25 FCFA et celle du vaccin Hitchner B1 à 5 FCFA. Le coût estimatif de la vaccination est de 35 FCFA pour Itanew et de 5 FCFA pour Hitchner B1. Le déparasitage interne est estimé à 5 FCFA par poussin, 30 FCFA par jeune, 40 FCFA par poule et 60 FCFA par coq sachant que, 1 comprimé de VPV coûte 40 FCFA. Le déparasitage externe est estimé à 100 FCFA par élevage. Le coût du supplément alimentaire distribué par mois est estimé à 80 FCFA par adulte et par jeune et à 20 FCFA par poussin, sachant que, 1 kg du mélange alimentaire coûte environ 70 FCFA.

Par conséquent, le coût total des dépenses engendrées par le programme est de 6.430 FCFA dans le groupe 1, de 119.750 FCFA dans le groupe 2 et de 7.665 FCFA dans le groupe 3.

Estimation des revenus

Le prix moyen de chaque classe de poulet est :

- Animaux non supplémentés : 150 FCFA pour les poussins, 700 FCFA pour les jeunes, 1.000 FCFA pour les poules, 2.000 FCFA pour les coqs

- Animaux supplémentés : 300 FCFA pour les poussins, 1.500 FCFA pour les jeunes, 2.500 FCFA pour les poules, 3.000 FCFA pour les coqs
- Bien que le prix des poussins soit estimé, ils ne se vendent pas en principe sur le marché local.
- 1- Estimation des revenus avant l'application du programme :
- Le prix de vente total des poulets est de 32.600 FCFA dans le groupe 1, de 49.550 FCFA dans le groupe 2 et de 4.000 FCFA dans le groupe 1.
- 2- Estimation des revenus après l'application du programme :
- Le prix de vente total des poulets est de 57.900 FCFA dans le groupe 1, de 528.800 FCFA dans le groupe 2 et de 47.000FCFA dans le groupe 3.
- Résultats financiers : (voir tableau III)
- Les résultats financiers sont calculés en utilisant la méthode préconisée par W. GOODGER [5]
- Cas du groupe1 : la différence en revenu est de 25.300 FCFA, le bénéfice est de 18.870 FCFA et le rendement est 3,93
- Cas du groupe2 : la différence en revenu est de 479.250 FCFA, le bénéfice est de 359.500 FCFA et le rendement est 4
- Cas du groupe3 : la différence en revenu est de 43.000 FCFA, le bénéfice est de 35.335 FCFA et le rendement est 5,60.

TABLEAU III. RÉSULTATS FINANCIERS.

	Groupe1 : (animaux vaccinés, déparasités)	Groupe2: (animaux vaccinés, déparasités, supplémentés)	Groupe 3 : (animaux vaccinés, déparasités, supplémentés avec protection des poussins contre les prédateurs)
Revenus	25.300	479.250	43.000
Dépenses totales	6.430	119.750	7.665
Coût des vaccins	1.555	5.855	575
Coût de la vaccination	2.125	8.015	755
Déparasitage interne	2.250	9.360	835
Déparasitage externe	500	800	100
Coût de l'aliment	-	95.720	5.400
Bénéfice	18.870	359.500	35.335
Rendement	3,93	4	5,6

DISCUSSION

Les résultats obtenus nous ont permis d'évaluer l'impact des interventions :

Dans les trois groupes étudiés au cours de la période 2, du fait du déparasitage et de la vaccination contre la maladie de Newcastle, nous avons observé dans les élevages, une absence de signes cliniques évoquant la maladie de Newcastle à partir du mois de décembre. Alors que cette période était habituellement propice à cette maladie avec de nombreuses mortalités [3]. L'absence de signes cliniques de maladie de Newcastle dans ces élevages, confirme nos résultats de la 2ème phase du travail selon lesquels, l'évaluation de l'efficacité de la vaccination par l'utilisation de la technique ELISA a montré un taux de protection des animaux allant jusqu'à 90% avec le vaccin Itanew [4].

Les pertes signalées sont dues essentiellement aux prédateurs chez les poussins et aux cas de vol chez les adultes dans le groupe 1 et dans le groupe 2 (voir tableau n°2). Par ailleurs, si nous comparons le taux d'animaux rentables pour les éleveurs à la fin des deux périodes dans le tableau n°1, nous constatons que dans chaque groupe, nous avons plus d'animaux pour la période 2 (période d'application du programme d'amélioration) que pour la période 1 (période sans intervention). Mais, nous devons noter que tous les vaccins disponibles sur le marché local sont importés. Par conséquent, du fait des ruptures en approvisionnement nous n'avons pas pu effectuer de vaccination à d'autres périodes avant novembre.

Dans le groupe 2 et groupe 3, nous constatons qu'après la mise en place de la supplémentation alimentaire, le gain de poids atteint 300g ou plus par mois pour les animaux de plus de deux mois d'âge. Alors que dans le groupe 1 où il n'existe pas de supplémentation alimentaire, de même qu'au début des deux autres groupes, le gain de poids est seulement de 150g au plus.

Les meilleures performances sont donc observées dans les groupes n°2 et n°3 où il est appliqué à la fois la vaccination contre la maladie de Newcastle et le déparasitage, associés à la supplémentation alimentaire. Ces résultats confirment l'étude de E.Sonaiya et col [6].

Dans le groupe 1 et groupe 2, en considérant les résultats notés dans le tableau n°2, les prédateurs sont la principale cause des pertes chez les poussins et les jeunes de 2 à 3 mois. Alors que dans le groupe 3, du fait de la lutte contre les prédateurs, les taux de perte chez les poussins et les jeunes de 2 à 3 mois sont très faibles. Par conséquent, le taux de réussite des poussins chez les jeunes (coquelets et poulettes), puis chez les animaux adultes est plus élevé dans le groupe n°3 que dans le groupe n°1 et n°2. En effet, au cours de la période 2, nous avons: dans le groupe n°1 au départ 16 poules, 8 jeunes et 18 poussins pour 13 animaux adultes produits en plus à la fin de l'intervention. Ce qui nous donne la valeur de 0,81 adulte à la fin pour 1 poule au départ pour quelle période ?. Dans le cas du groupe n°2, nous avons au départ 70 poules, 89 jeunes et 83 poussins pour 61 animaux adultes produit en plus à la fin de l'intervention. Ce qui nous donne la valeur de 0,87 adulte à la fin pour 1 poule au départ. Dans le cas du groupe n°3, nous avons au départ 2 poules, 0 jeune et 0 poussin pour 7 animaux adultes produit en plus à la fin de l'intervention; Ce qui nous donne la valeur de 3,5 adultes à la fin pour 1 poule au départ dans un élevage où il n'existait ni poussins, ni jeunes animaux. Ceci démontre que la protection des poussins contre les prédateurs est une voie efficace pour améliorer la productivité et augmenter l'effectif en aviculture familiale lorsqu'elle est associée à la vaccination et au déparasitage.

Les résultats financiers montrent que le rendement dans les groupes 1, 2 et 3 sont respectivement : 3,93 ; 4 ; et 5,60. D'après la méthode de W. Goodger [5], un rendement supérieur à 1 signifie que le programme appliqué est bénéfique pour l'éleveur. Donc les programmes que nous avons appliqués dans chaque groupe sont bénéfiques pour les éleveurs par rapport à la situation sans soins particuliers. Mais, il convient de remarquer que le meilleur programme avec le rendement le plus élevé 5,60 est celui appliqué dans le groupe n°3. C'est à dire un programme d'amélioration qui inclut la vaccination, le déparasitage, la supplémentation alimentaire et la protection des poussins contre les prédateurs.

CONCLUSION

A l'issu de notre travail, il apparaît que l'aviculture familiale contribue à améliorer les moyens d'existence des populations surtout en milieu rural. Soit en leur fournissant directement les protéines d'origine animale disponibles pour la consommation, soit en leur fournissant de l'argent lors des échanges. L'aviculture familiale améliorée favorise donc la sécurité alimentaire et aide à lutter contre la pauvreté dans les couches sociales les plus défavorisées.

Pour encourager les personnes les plus vulnérables : femmes, enfants, handicaps, les familles affectées par le SIDA et victimes de guerre [8], le programme d'amélioration de l'aviculture familiale doit être développé à grande échelle au niveau de la population en Côte d'Ivoire. La population cible doit être soutenue dans l'approvisionnement en intrants tel que les vaccins, dont la production locale entraînera un faible coût à l'achat, et pourra résoudre le problème de l'importation qui provoque des ruptures de stocks sur le marché. Le vaccin I-2 qui présente des avantages scientifiquement prouvés : thermostable, facile à utiliser sur le terrain (inoculation par voie oculaire), capable de protéger les animaux non vaccinés par simple contact avec ceux vaccinés [1], [2], [7]; peut être introduit et produit sur place en Côte d'Ivoire pour le bonheur de la population. Un autre niveau de soutien à la population cible doit être la mise à leur disposition de système de crédits remboursables au bénéfice de l'amélioration de l'aviculture familiale.

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ASSESSING THE ECONOMIC IMPACT OF COMMERCIAL POULTRY FEEDS SUPPLEMENTATION AND VACCINATION AGAINST NEWCASTLE DISEASE IN LOCAL CHICKENS, IN KENYA

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Abstract

Despite of the rapid growth in poultry population in the past decade, various constraints continue to adversely affect the productivity of local birds in Kenya. Sustainable cost effective interventions are necessary if full potential is to be realised. The impact of Newcastle disease (ND) control using vaccination and commercial poultry feed supplementation was assessed in 16 farms found in Kiambu district (ECZ II). Information on flock size, flock structure and disease control was gathered from these farms. F strain ND vaccine administration and commercial poultry feed supplementation was also done. Generally there was a notable increase in flock size when birds were supplemented and vaccinated. There was marked increase in numbers of growers and chicks with feed supplementation and vaccination. It was economically profitable to supplement and vaccinate local birds as returns were >1.0. Vaccination gave the highest return on investment (3,36) and feed supplementation the least (1,15). The high cost of commercial poultry feed discourages farmers from supplementing local chicken; therefore farm formulations using locally available materials should be encouraged. There is need to produce thermostable vaccines locally to use in local birds which would bring vaccine costs further down.

INTRODUCTION

The poultry population in Kenya has continued to increase in the past decade. There are approximately 29 million chickens comprising of broilers, layers and local chicken. Over 70% of the national flock consists of local chicken mainly kept under free range conditions. These chickens are a major source of protein in form of eggs and meat and a source of cash income especially for over 90% of the rural households (Anon, 2000).

Although the local chicken production has continued to thrive over the years and the role it plays in poverty alleviation is documented (Ndegwa, et al., 2000), there still remain major constraints. Their contribution to the national economy and the per capita meat and egg consumption is quite low. Generally, the productivity of local chicken is low and needs to be improved. Poor management practices and infectious diseases among them, the devastating Newcastle disease (ND) continue to impede the full exploitation of the local birds. In the recent past, surveys and cross sectional studies have been carried out with the ultimate goal of generating data which can be used to improve the production of these birds. From these studies, it is evident that interventions are necessary in the areas of feeding, housing, disease control, research, extension, training, marketing and micro finance.

This study set out to assess the economic impact of two interventions, namely control of Newcastle disease through vaccination and feed supplementation using commercial feed.

MATERIALS AND METHODS

Study site

The study was carried out in Kiambu district which is situated within the vicinity of Kabete Veterinary Research Laboratories. The choice of the district was based on results of two previous studies conducted by Njue et al. (2001, 2002) in Kiambu (ECZ II) and Machakos (ECZ III) districts which showed that there was no significant statistical difference in poultry production parameters between the two districts.

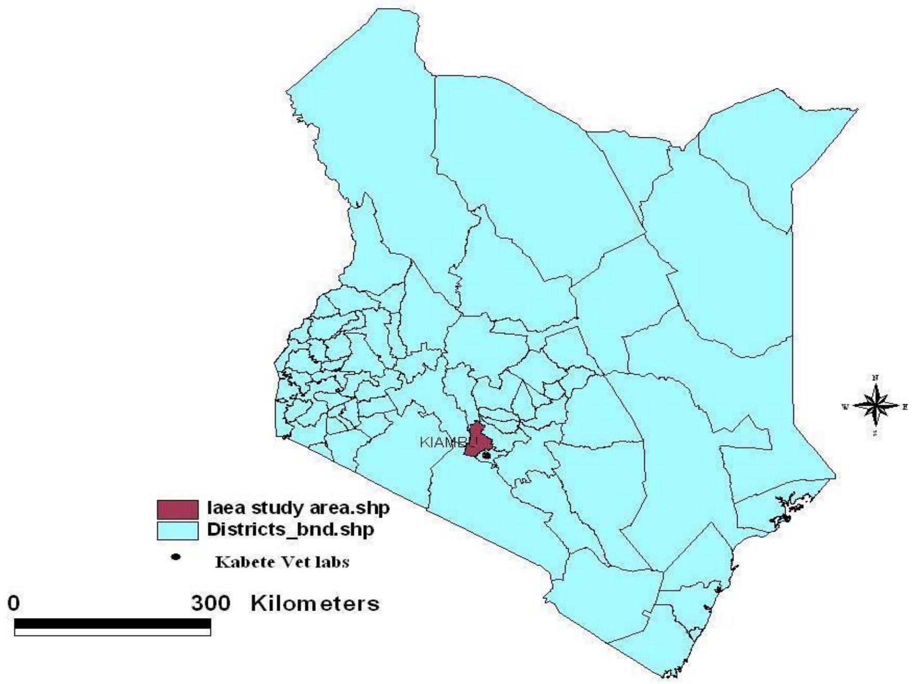

FIG. 1. Map ok Kenya showing the study area

Selection of villages and farms

Kabete and Nyathuna villages of Kiambu district which had previously been used for earlier studies by Njue et al (2001, 2002) were selected for this study. Sixteen poultry farmers were selected from the two villages. To qualify for the study, the poultry farmer had to be a female with the main aim of keeping chicken for enhanced household nutrition and cash income. Half of the farmers who were selected for this study had previously participated in previous studies by Njue et al (2001, 2002). The remaining half of the farmers were recruited from the two villages. In this study, the flock was the unit of interest.

Study design

Sixteen farms were assigned different treatments over a period of six months from July 2003 to December, 2003 as shown in Table I below:

TABLE I. ALLOCATION OF TREATMENTS TO 16 FAMILY POULTRY FARMS IN KIAMBU DISTRICT, CATEGORISED BY VILLAGES.

Village	Type of Treatment and number of households (and chicken population)				Total
	Vaccinated and Feed supplementation	Vaccinated, No Feed supplementation	Feed supplementation Not vaccinated	No feed supplementation Not vaccinated	
Kabete	2 (47)	2 (57)	2 (40)	2 (16)	8 (160)
Nyathuna	2 (75)	2 (54)	2 (76)	2 (36)	8 (241)
Total	4 (122)	4 (111)	4 (116)	4 (52)	16 (401)

Study procedure

The study was conducted from July 2003 to December 2003. Birds from half of the farms were vaccinated against Newcastle disease using F strain of ND vaccine via the nose drop route (100microlitres/bird)). The vaccinations were started in July 2003 and were given at one and a half month interval. Birds from another half of the farms were supplemented using a well balanced commercial poultry growers mash. Feed was given to the birds of all ages at the rate of 50 g/bird/day throughout the six months period. In addition, information on flock composition and dynamics and disease control was collected using data collection sheets. Table II below illustrates activity chart.

TABLE II. ACTIVITIES UNDERTAKEN IN 16 FAMILY POULTRY FARMS IN KIAMBU DISTRICT, JULY–DECEMBER 2003.

Activity carried out	Person responsible	Interval	July	Aug	Sept	Oct	Nov	Dec
Distribute poultry feed to farmers	Animal health assistant (AHA)	2 weeks	x x	x x	x x	x x	x x	x x
Collect information	Researchers & AHA	6 weeks	x	x		x	x	
Vaccinate with ND F strain vacc.	Researchers & AHA	6 weeks	x	x		x	x	

Data management and storage

Derived variables and other data were synthesized into appropriate variables. Where applicable these were appropriately coded. Each type of datum was entered and stored in separate spreadsheets (Ms Excel spreadsheet (Ms Excel 2000, USA)). These spreadsheets were then screened for proper coding and errors in data entry were corrected.

Analysis

Descriptive statistics

Ms Excel spreadsheet was used to generate descriptive statistics of the variables

Partial budget analysis

The economic variables gathered were subjected to partial budget analysis whereby the effects of interventions were assessed. Return on investment was used to determine the economic profitability whereas profit was used to compare across the interventions as follows:

$$\text{Return on investment} = \frac{\text{Increased income}}{\text{Increased cost}}$$

Profit = Increased income - Increased cost

RESULTS

Changes in average flock sizes of local chickens on 16 farms participating in the study

The results of the statistical analysis of flock numbers obtained from 16 poultry farms in Kiambu district are summarised as shown in Table III below. There was no statistical difference in average flock sizes during the first and second farm visits (P=0.4604), first and third visit (P=0.9113), first and fourth visit (P=0.5729). The average flock sizes were similar during the second and third visits (P=0.3988), second and fourth visits (P=0.7706), third and fourth visits (P=0.6492) for all the treatments. There was no statistical difference in average flock sizes between supplemented birds and vaccinated birds (P=0.6340), supplemented and vaccinated supplemented (P=0.6014). No differences were observed between vaccinated and vaccinated supplemented (P=0.3281), vaccinated supplemented and controls (P=0.1757). There was however difference between flock sizes of supplemented and controls (P=0.0742), Supplemented birds had larger flock sizes than controls. Vaccinated flocks were also larger than controls (P=0.0322).

TABLE III. AVARAGE FLOCK SIZES IN RELATION TO THE TIME OF VISIT.

Treatment	Average flock sizes			
	1st Visit (Early July)	2nd Visit (Mid August)	3rd Visit (Early October)	4th Visit (Mid November)
Commercial poultry feed suppl.(n=4)	21.7	27.1	41.9	27.5
ND- vaccination (n=4)	16	42.6	35.6	25.2
Com. poultry feed suppl. & ND-vacci-nation(n=4)	28.4	38.4	40.8	29.6
Controls (n=4)	9.7	14.1	12.6	8.6

Flock composition of the 16 poultry farms visited during the study

Figures 1–4 show changes in flock composition over the study period. In farms supplementing with commercial poultry feed, there was a general increase in the number of birds from each category on every visit as shown in Fig. 1. The highest average number was 13 hens in the third visit and the lowest was 2 cocks in the fourth visit. In the farms where vaccination was taking place (Fig. 2) there was increase in the number of chicks all through with an average number of 10 during the second visit. There was no much difference in the number of growers and chicks from the farms where vaccination and supplementation was practised in the third and fourth visit as shown in Fig. 3. The flock size for the controls was small right from the beginning (Fig. 4). Generally the numbers particularly for cocks and hens were low during the fourth visit. The minimum average numbers were for cocks, growers and chicks in the control group during the first visit.

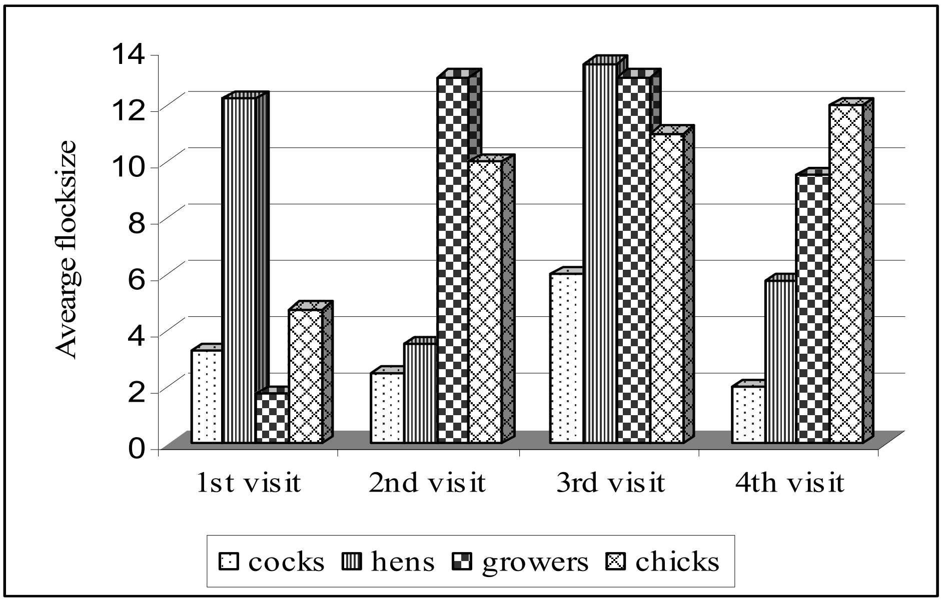

FIG. 1. Variation in flock size in the farms practising commercial poultry feed supplementation

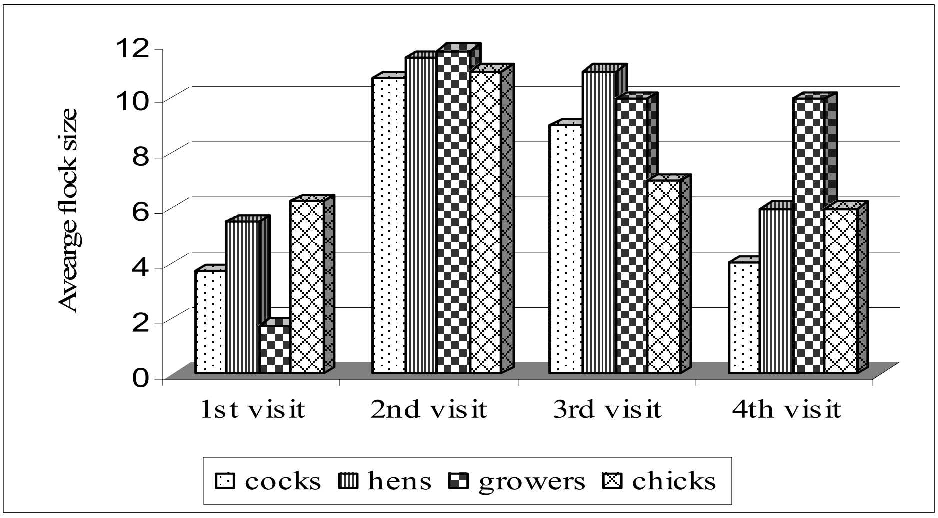

FIG. 2. Variation in flock size in the farms practising Newcastle Disease vaccination

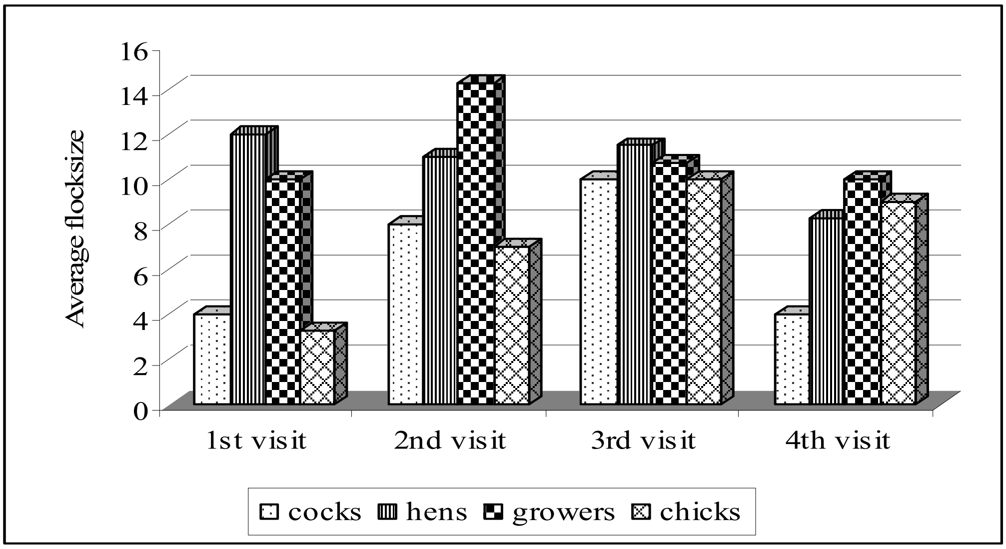

FIG. 3. Variation in flock size in farms practising Nd- vaccination and commercial Feed supplementation

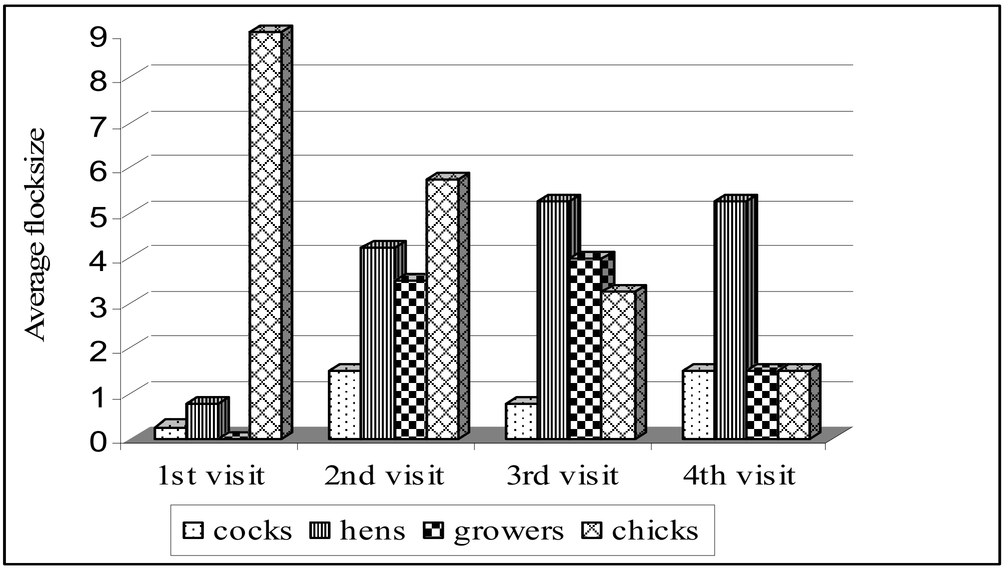

FIG. 4. Variation in flock size in the control farms

Additional income and expenditure realised from 16 farms selected for the study

Table IV below shows the additional income and expenditure arising from different treatments over a period of 6 months. Income was entirely derived from the number of local chicken withdrawn (sold, consumed or given out as token) from each treatment group. The group receiving commercial poultry feed supplementation and Newcastle disease vaccination had the largest withdrawal of 270 birds whereas the control group had the least (99 birds). Costs were incurred from purchase of vaccine, fuel, feed and payment of labour. Feed was the most expensive whereas vaccine was the cheapest

TABLE IV. INCOME AND EXPENDITURE FOR SIX MONTHS ON THE 16 SELECTED FARMS RECEIVING TWO TREATMENTS.

	Commercial poultry feed supplementation (n=4)		ND-vaccination (n=4)		Commercial feed suppl. & ND-vacc.(n=4)		Controls (n=4)	
	Quantity	Unit cost in $	Quantity	Unit cost in $	Quantity	Unit cost in $	Quantity	Unit cost in $
Cocks	52	3.21	28	3.21	85	3.21	17	3.21
Hens	47	2.56	93	2.56	130	2.56	38	2.56
Growers	95	1.92	103	1.92	55	1.92	44	1.92
Vaccine	0	0	1120	0.03	1350	0.03	0	0
Fuel	133.3 L	0.77	83.3 L	0.77	133 L	0.77	83.3 L	0.77
Labour	12 days	6.94	4 days	16.03	12 days	6.94	4 days	16.03
Feed	862kg	0.26	0	0	1200kg	0.26	0	0

Economic analysis of the intervention methods used during the study

Results of economic analysis are shown in Table V below. Profits were obtained by the sum of increased benefits less the sum of increased costs associated with the interventions. The benefit considered here was the increased number of birds. It was more profitable to vaccinate the birds ($369.56) and less profitable to supplement the birds with commercial poultry feed ($59.87). Return to investment was obtained by comparing incremental benefits with incremental costs. In terms of return to investments, all the interventions were beneficial. Returns to investments were greatest for vaccination (3.35) and lowest for commercial poultry feed supplementation (1.51).

TABLE V. RESULTS OF ECONOMIC ANALYSIS OF VARIOUS INTERVENTION METHODS USED TO IMPROVE PRODUCTIVITY OF LOCAL CHICKEN.

	Vaccination with feed suppl.	Vaccination alone	Feed suppl. alone	Controls
Increased income	$711.54	$526.28	$469.87	$236.54
Increased cost	$532.62	$156.72	$410	$128
Vaccine cost	$34.62	$28.72	$0	$0
Fuel cost	$103	$64	$103	$64
Labour cost	$83	$64	$83	$64
Feed cost	$312	$0	$224	$0
Profit	$178.92	$369.56	$59.87	$108.54
Return	1.34	3.36	1.15	1.85

DISCUSSION

The results of this study indicate that there are differences in average flock sizes and structure dependeding on the type of intervention. In the farms where supplementation was done, the highest average flock sizes were realised in the third visit. The numbers of growers and chicks were generally high in the subsequent visits. This confirms that feed supplementation can contribute to improved poultry production. In this study, vaccination was done at 6 weeks interval to build up on immunity of flocks from newly recruited farmers. This was done because the results of previous baseline survey conducted by Njue et al. (2001) indicated that ND antibody levels were higher in the unvaccinated birds during the dry season (June-Mid-October, Jan –Mid March) than the wet season (Mid March –May, Mid October-December). From this study, vaccination appears to have a positive effect on the numbers of growers and chicks. However, vaccination cannot be said to have protected the birds during the study period as there was no outbreak of Newcastle disease. This confirms the observation by Spradbrow (2001) that ND outbreaks are only indirectly attributed to seasonal conditions. Past studies in commercial birds by Alexander (1998) indicate that vaccination hinders the spread of the disease within the flocks and these observations are applicable to ND in local chickens. The number of cocks, hens and growers tended to decrease during the fourth visit due to high off take associated with Christmas festivities as had been noted in earlier studies by Njue *et al*, 2002.

Economic analysis results indicate that it is economically profitable to use commercial poultry feed supplementation, ND vaccination as well as commercial poultry feed supplementation combined with ND vaccination. The returns to investment were all greater than one. From this study, the most profitable way to improve poultry production is through control of Newcastle disease by vaccination ($369.5). The cost of vaccine is relatively low ($0.03/dose) and is affordable by most local poultry farmers. Feed was the most expensive input ($0.26/kg). The high cost prohibits its use on local chicken. It is only marginally profitable ($59.87) to supplement the local birds with commercial poultry feeds. This was also noted by Maingi (2002).

CONCLUSION AND RECOMMEDATIONS

From the results of this study, it is evident that:

- Feed supplementation improves the productivity of local birds but the profit margin is much lower when they are supplemented with commercial poultry feed. Therefore farm feed formulations using locally available material should be encouraged. These include sorghum, cassava, cow peas, Amaranthus seeds, fish (Dagga), among others. These feedstuffs are cheap than the conventional feeds and are more readily available. The estimated costs of dagga is $ 0.64 , sorghum $0.19, cassava $0.26, and, cowpeas $0.32 per kg,. The amaranthus seed is normally free in the villages.
- Vaccination against Newcastle disease leads to improved local poultry production. There is need to produce thermostable vaccines locally which would bring vaccine costs further down.The other advantage is the possibility of smaller and appropriate doses for the small flocks

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IMPACTS DE LA VACCINATION ANTI - MALADIE DE NEWCASTLE ET DU DEPARASITAGE DES POUSSINS SOUS MERE SUR LA PRODUCTIVITE DE L'AVICULTURE VILLAGEOISE A MADAGASCAR

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Résumé

L'enquête socio-économique et épidémiologique effectuée au niveau de l'aviculture villageoise malgache a révélé l'importance des contraintes sanitaires, en particulier, de la maladie de Newcastle (MN) et des parasitoses internes dans la limitation de la productivité du sous-secteur avicole traditionnel. Dans le but d'améliorer cette productivité, une vaccination anti-MN pour toutes les classes et un déparasitage des poussins sous mère ont été entrepris afin de maîtriser ces deux facteurs majeurs de mortalité. L'évaluation des résultats obtenus, selon les paramètres « mortalité » et « variation des cheptels » est en faveur des impacts positifs des interventions, avec une augmentation de +49% l'année des effectifs élevés, une augmentation de +166% des effectifs exploités, une diminution du taux de mortalité globale de 39% environ à 21% pendant la même période. En se référant sur les effets résiduels des contraintes sanitaires liées aux maladies ciblées, il en ressort que les résultats sont effectivement en rapport avec la maîtrise de la MN et des parasitoses internes des poussins sous mère.

Abstract

IMPACTS OF ANTI-NEWCASTLE DISEASE VACCINATION AND CHICKS ANTI-PARASITIC TREATMENT ON VILLAGE POULTRY PRODUCTION IN MADAGASCAR.

The socio-economic and epidemiological survey carried out on village poultry in Madagascar revealed the importance of health constraints, particularly Newcastle disease (ND) and internal parasites, in limiting the productivity of the traditional poultry sub sector. With the aim of improving this productivity anti-ND vaccination for all classes of birds and anti-parasite treatment of chicks was undertaken so as to control these two major factors contributing to mortality. Evaluation of the results obtained for mortality and variation in numbers suggested a positive effect of the interventions, with an increase of 49% in the numbers raised, an increase of 166% in the numbers used, and an overall decrease in mortality from 39% to 21% in the same period. The residual prevalence of the two diseases targeted suggested that they had been controlled.

INTRODUCTION

A Madagascar, l'élevage des volailles de race locale fait partie intégrante des activités des populations partout dans le territoire national, en particulier en milieux rural et péri-urbain.

Dans les zones rurales, le système d'élevage de type traditionnel est caractérisé par de faibles intrants : peu ou pas de complémentation alimentaire, absence de poulaillers, insuffisance ou même absence de protection sanitaire ou amélioration génétique. En conséquence, les retombées socio-économiques restent relativement faibles [1].

L’enquête socio-économique et épidémiologique effectuée au niveau de l’aviculture villageoise malgache dans deux zones écologiques différentes a confirmé cette faiblesse de revenus tirés du sous-secteur avicole traditionnel : une famille bénéficie en moyenne, seulement de 7 volailles en bonne santé l’année (la partie consommée après chaque passage de maladie de Newcastle, non comprise) [2]. La même enquête a permis de révéler la présence de plusieurs contraintes entraînant la stagnation de la productivité du système. Toutefois, pour le genre *Gallus*, ces contraintes sont dominées par la maladie de Newcastle (MN) et le parasitisme interne. Si la MN intéresse toutes les classes, les maladies causées par les vers parasites touchent principalement les poussins. D’autres maladies infectieuses ont été rencontrées, à savoir, la variole et la pasteurellose aviaires, mais en se référant sur les résultas obtenus, leurs impacts restent marginaux dans les deux zones d’étude.

Le présent projet se propose de maîtriser ces deux contraintes majeures en vaccinant tout le cheptel contre la paramyxovirose et en traitant systématiquement tous les poussins sous mère avec un anti-parasitaire. La période d’expérimentation va du mois de décembre 2000 au mois de novembre 2001 soit une durée totale de 12 mois.

MATERIEL ET METHODES

Zones d’étude

Les zones d’expérimentation sont celles de l’enquête épidémiologique effectuée durant l’année 1999-2000, à savoir (voir FIG. 1)

- la zone écologique n°1 d’Ambohimangakely avec ses trois villages numérotés 11, 12 et 13 (Ambohimangakely, Betsizaraina et Alatsinainy).
- La zone écologique n°2 de Moramanga avec ses trois villages numérotés 21, 22 et 23 (Mangoro-Ankarahara, Ankarefo et Ambodin’Ifody Gara).

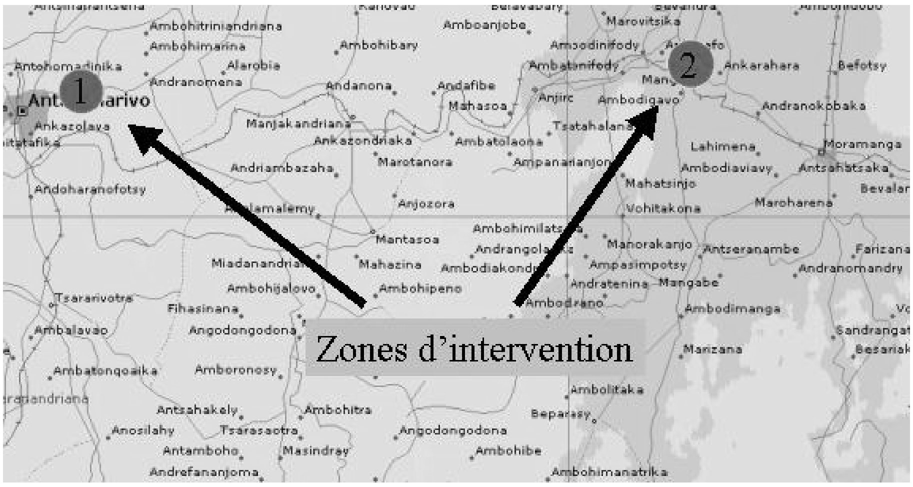

FIG. 1. Carte des zones d’interventions

Protocole

Il s’agit de mettre en œuvre un programme de traitement approprié contre les vers parasites, chez les poussins en particulier, et de fixer un planning de vaccination anti-Newcastle sur la totalité du cheptel étudié (FIG. 2).

Traitement anti-parasitaire

Deux anthelminthiques ont été utilisé : le premier est un produit à base du tétramisole de nom déposé Sodivermyl® (BIARD), administré à la dose de 1 comprimé par kg de poids vif ; le deuxième est un vermifuge polyvalent (LAPROVET) renfermant du lévamisole, du niclosamide et de la vitamine A, administré à la dose de 1 comprimé par 2 kg de poids vif.

Le rythme individuel des traitements des poussins conçus à titre préventif tient compte de la dynamique de l'apparition des maladies parasitaires constatée lors de l'enquête épidémiologique ; autrement dit, le premier traitement doit avoir lieu avant l'apparition des premiers symptômes. Aussi, le premier drogage a été programmé vers la fin de la première semaine (à 5–7 jours d'âge) ; le second, à un mois une semaine (37 jours) d'âge et le dernier à 2 mois et une semaine d'âge (67 jours d'éclosion du poussin). Par conséquent, chaque couvée reçoit trois traitements espacés chacun d'un mois, couvrant ainsi normalement toute la période de vie des poussins avec leurs mères.

Vaccination anti-Newcastle

Le premier vaccin anti-Newcastle utilisé est le vaccin TAD NDV vac Hitchner B1®, dont le conditionnement s'élève à 1000 doses par flacon. Chaque flacon est dilué avec 50 ml d'eau de puits d'origine locale de manière à avoir une dose par 50µl. Le vaccin est administré par voie oculaire sous un volume de 25µl par oeil. Chaque individu reçoit une dose quel que soit l'âge, répétée deux fois à un mois d'intervalle. La durée d'immunité est estimée à 4 mois. Le poussin est vacciné à partir de 15j d'âge.

Le deuxième vaccin concerne la Pestavia® : vaccin anti-Newcastle à souche Mukteswar, produit localement par l'Institut Malgache des Vaccins Vétérinaires (IMVAVET) sur cellules, il est administré en S/C à la dose de 1 ml par individu. Pour les poussins de 15j, la dose est réduite à 0,5 ml. La durée d'immunité est estimée à 1 an

Pour les deux vaccins expérimentés, une primo-vaccination est suivi d'une vaccination à 1 mois d'intervalle.

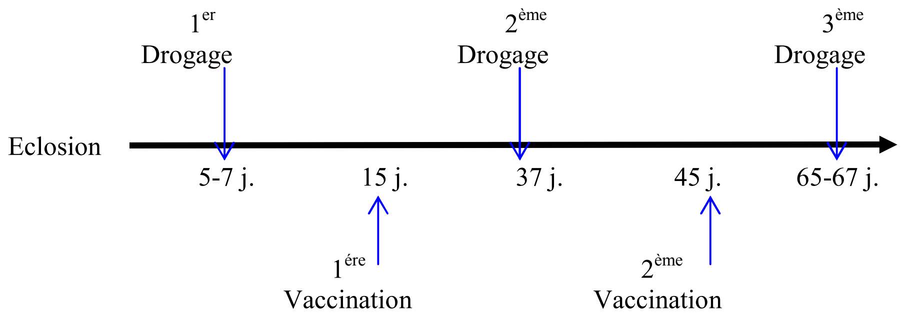

FIG. 2. Protocole de déparasitage et de vaccination anti-MN

Collecte des données

La collecte des données consiste à compter sur des fiches le nombre des volailles existantes à l'occasion des descentes mensuelles. Les mouvements sont marqués, qu'ils soient sous forme de vente/consommation/don, de vol ou de disparition, de changement de classe ou de mortalité. En ce qui concerne les mortalités, elles sont identifiées en fonction de leurs causes sur la fiche d'évolution du cheptel.

Analyse économique

L'analyse économique permet de voir la rentabilité, ou non, des interventions entreprises. Il s'agit donc de comparer les coûts de production aux revenus générés.

RESULTATS

Evolution du cheptel

Effectifs réels

La variation mensuelle des effectifs réels autrement dit, du nombre de volailles élevées pendant 12 mois de suivi, calculée en fonction de l'effectif initial, chez 35 familles encadrées montre une successiond de périodes soit de régression soit d'augmentation. L'effectif aviaire passe de 738 à 521 de décembre 2000 au mois d'avril 2001 puis augmente du mois de mai jusqu'au mois de novembre 2001 (Tableau I).

TABLEAU I. EVOLUTION DES EFFECTIFS ELEVES DES DEUX ZONES.

Dates	Classe poussin (C)	Classe poulette (G)	Classe adulte femelle (AF)	Classe adulte mâle (AM)	Effectif Total	% d'augmentation (v.s régression)
Déc. 2000	321	263	114	40	738	-
Janv. 2001	291	225	111	34	661	-10,43
Fev 2001	267	204	111	24	606	-17,88
Mars 2001	207	187	109	22	625	-5,15
Avril 2001	192	195	108	26	521	-29,40
Mai 2001	243	191	128	34	596	-19,24
Juin 2001	435	220	139	39	833	+12,87
Juillet 2001	591	212	150	39	992	+34,41
Août 2001	471	283	154	40	948	+28,45
Sept.2001	483	296	162	44	985	+33,46
Oct. 2001	458	360	173	47	1038	+40,65
Nov. 2001	511	367	176	45	1099	+48,91

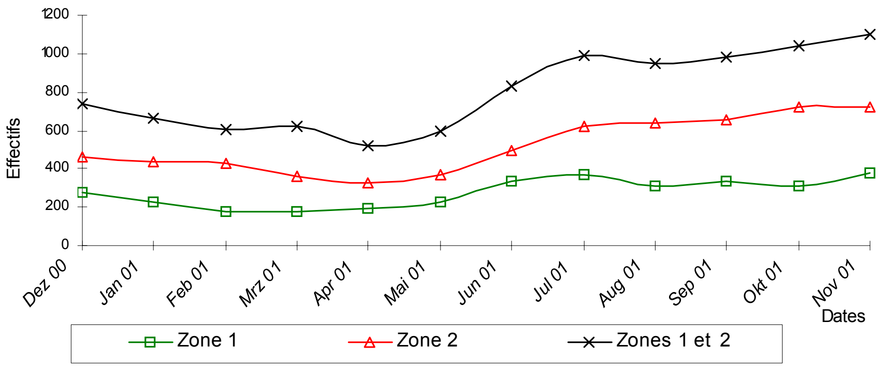

FIG. 3. Courbe d'évolution des effectifs en 12 mois

En traçant les courbes correspondantes à l'évolution de chaque classe, les variations mensuelles ci-dessus décrites deviennent beaucoup plus visibles. La courbe représentant le cheptel total régresse pendant les quatre premiers mois (jusqu'au mois d'avril) et de là, remonte à partir du mois de mai pour rester croissante jusqu'à la fin du suivi (novembre 2001) avec toutefois, une petite phase décroissante au mois d'août 2001 (FIG. 3).

Il est à remarquer que la variation de l'effectif total est parallèle à celle des poussins qui présente une très nette augmentation du mois de mai au mois de juillet 2001 (Tableau I).

Enfin, le nombre des adultes reste quasi-stationnaire avec une moyenne de 5 poules et un peu plus d'un coq par ménage à la fin du suivi.

Effectifs exploités

Le nombre de volailles exploitées durant les 12 mois représente 97,3 % de l'effectif initial (718 sur 738 volailles), un taux d'exploitation très élevé. Cette situation explique l'apparente stagnation de l'effectif qui, pendant la même période, n'a connu qu'une augmentation relativement modeste de +48,9 %. (Tableau II)

TABLEAU II. EVOLUTION DES EFFECTIFS EXPLOITE.

Périodes	**C**	G	AF	AM	Effectif Total
Déc. 2000	-	-	-	-	-
Janv. 2001	0	68	3	3	74
Février 2001	4	119	5	5	133
Mars 2001	2	58	6	0	66
Avril 2001	10	42	4	1	57
Mai 2001	7	30	0	1	38
Juin 2001	0	29	1	1	31
Juillet 2001	0	29	4	3	36
Août 2001	1	67	4	1	73
Sept.2001	3	48	1	0	52
Octobre 2001	3	72	5	2	82
Nov. 2001	0	68	5	3	76
Total	30	630	38	20	718
Pourcentage	4,2 %	87,7 %	5,3 %	2,8 %	100 %

L'exploitation de volailles a lieu durant toute l'année. Toutefois, il existe des périodes d'affluence pendant lesquelles le taux d'exploitation reste très élevé: c'est le cas de la saison située entre le mois de janvier jusqu'au mois d'avril avec un pic au mois de février et également de la période comprise entre le mois d'août jusqu'au mois de novembre (FIG. 4). Entre les deux saisons favorables existe une petite période maigre de durée égale à 3 mois (mai à juin) où l'exploitation est minimale: elle correspond précisément à la phase de reproduction maximale des volailles dans le système traditionnel et par conséquent, au rajeunissement du cheptel.

Suivant la répartition des volailles exploitées par classe d'âge, il est clair que le poulet est le produit principal de l'aviculture villageoise malgache: il représente à lui tout seul plus de 87% de la partie exploitée.

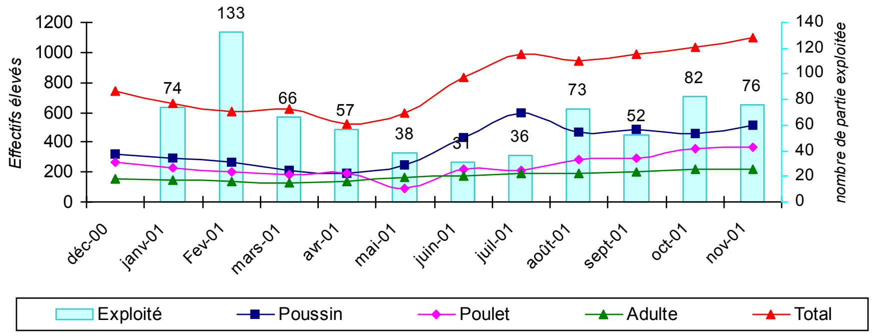

FIG. 4. Courbe d'évolution des effectifs élevés et la partie exploitée

Répartition des effectifs exploités par destination

La répartition par destination de la partie exploitée montre que la consommation l'emporte légèrement sur la vente car les 54,32% sont autoconsommés (Tableau III).

TABLEAU III. REPARTITION PAR DESTINATION.

Destination	C	G	AF	AM	Total	Pourcentage
Vente	9	295	8	8	320	44,57 %
Consommation	21	328	29	12	390	54,32 %
Don	0	7	1	0	8	1,11 %
Total	30	630	38	20	718	100 %

Effectifs cumulés

Les effectifs élevés recensés lors des descentes, chez les 35 familles, ne reflètent que partiellement les résultas totaux. La considération de la partie exploitée en plus du cheptel élevé dans le cumul des effectifs fait sortir la totalité des impacts (Tableau III).

Il ressort du Tableau IV que l'augmentation réalisée en 12 mois s'élève à +146,20 % par rapport à l'effectif d'origine.

TABLEAU IV. EFFECTIF CUMULE DES DEUX ZONES.

Dates	Effectif réel	Effectif exploité	Effectif cumulé	Augmentation
Déc. 2000	738	-	738	-
Janv. 2001	661	74	735	- 0,40 %
Février	606	133	813	+ 10,16 %
Mars	625	66	898	+ 21,68 %
Avril	521	57	851	+ 15,31 %
Mai	596	38	964	+ 30,62 %
Juin	833	31	1232	+ 66,93 %
Juillet	992	36	1427	+ 93,36 %
Août	948	73	1456	+ 97,28 %
Septembre	985	52	1545	+ 106,64 %
Octobre	1038	82	1680	+ 127,64 %
Novembre	1099	76	1817	+ 146,20 %

Mortalité

Mortalité globale

En intervenant sur les deux contraintes majeures (MN et parasitoses internes), le taux de mortalité totale passe de 38,71% à 21,07%. Cette diminution est d'ailleurs le reflet des résultats obtenus au niveau de chaque classe : si les taux de mortalité s'élèvent à 42,34%, 33,95% et 31,42% respectivement pour les classes « poussin », « poulette » et « adulte » avant interventions, les taux correspondants ne sont plus que, respectivement de 29,3%, 7,69% et 7,92%, après interventions (FIG. 5)

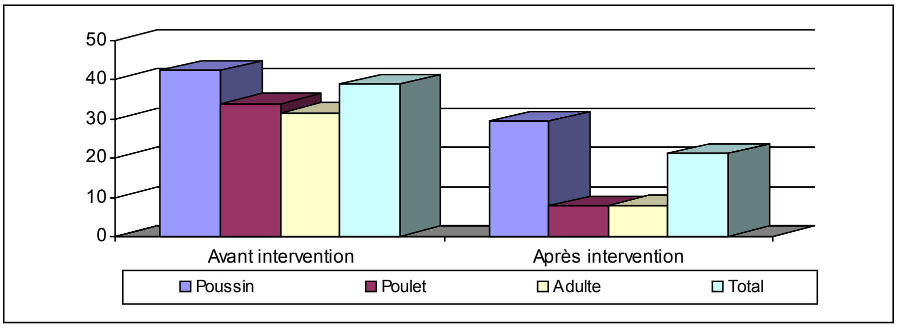

FIG. 5. Mortalité totale avant et après interventions

Mortalité des poussins

Bien que certains ménages soient victimes de MN (ménage 121 à HB1 et ménage 236 à Pestavia), les résultats nous montrent une forte diminution des contraintes sanitaires liées à cette maladie et aux parasitoses internes. Pour cette classe d'âge, le taux de mortalité due à la MN est passé de 25,3 % à 4,24 % ; quant aux helminthes, la part de mortalité attribuable à ces parasites a pu être réduite de 38,5 % (taux annuel avant interventions) à 10,22 % (taux annuel après interventions) (Tableau V).

TABLEAU V. COMPARAISON DES MORTALITES DES POUSSINS AVANT ET APRES INTERVENTIONS. (DEC.2000 A NOV.2001)

Causes	Mortalités			
	Après interventions		Avant interventions	
	nombre	%	nombre	%
NDV	27	4,2	201	25,3
Variole aviaire	37	5,8	29	3,6
Cholera aviaire	0	0	35	4,4
Parasitisme	65	10,2	306	38,5
Voiture	22	3,5	34	4,3
Prédateur	145	22,8	76	9,6
Autres	359	53,5	113	14,2
Total	655	100	794	100
Taille du cheptel	2234		1875	

Il semblerait que la variole ait accentué sa pression en comparant les taux de mortalité respectifs dus à cette virose avant et après les interventions (3,6 % et 5,8 %). En fait, il n'en est rien, car, en calculant les pourcentages que représentent les nombres des poussins victimes de la variole dans les deux situations, les chiffres obtenus s'élèvent respectivement à 1,8 % (avant interventions) et 1,65 % (après interventions), des chiffres quasi-stationnaires.

Par contre, on assiste à une relative recrudescence du facteur « prédateur » dont la part est non seulement augmentée en terme de pourcentage par rapport aux mortalités (22,8 % contre 9,6 % avant interventions) mais aussi en terme de proportion par rapport aux effectifs totaux des poussins: 76 poussins sont enregistrés victimes de la prédation avant interventions, ce qui correspond à 4,1 % du nombre total (76/1875); les chiffres correspondants s'élèvent à 145 poussins représentant 6,5 % de l'effectif des poussins (145/2234) après les interventions. (Tableau VI)

Le facteur «autres» a pris le dessus sur toutes les contraintes en causant la perte de plus de 53 % des mortalités. Nous rappelons que ce facteur englobe le piétinement des poussins, l'égarement, les intempéries (froid, pluie, cyclone, etc…), la sous-alimentation, les intoxications, divers accidents etc..

Mortalité des poulets

Pour cette classe, une très nette diminution des mortalités a été réalisée : le nombre des poulets morts passe de 314 (n=925) à 83 (n=1080) soit une réduction de plus de 73 %

TABLEAU VI. MORTALITES DES POULETS AVANT ET APRES INTERVENTIONS.

Causes	Mortalités			
	Après interventions		Avant interventions	
	nombre	%	nombre	%
NDV	15	18,07	216	68,80
Variole aviaire	0	0	0	0
Choléra aviaire	1	1,20	15	3,84
Parasitisme	1	1,20	18	5,75
Voiture	21	25,30	23	7,32
Prédateur	11	13,25	15	4,78
Autres	34	40,96	27	8,59
Total	83	100	314	100
Taille du cheptel (n)	1080		925	

L'impact direct sur les maladies ciblées est palpable avec une réduction de l'influence de la MN dont la part de mortalité n'atteint plus que 18,07 % contre 68,80 % avant vaccination; il en est de même des parasitoses internes qui, auparavant étaient reconnus comme étant la cause des 5,75 % des mortalités de la classe poulette contre 1,20 % après les traitements (Tableau VII). Ici encore, le facteur « autres » est responsable des 40 % au moins des mortalités recensées.

Les dégâts causés par les prédateurs et la voiture restent tout de même stationnaires bien que les proportions des victimes correspondantes se trouvent fortement augmentées.

Mortalité des adultes

La maîtrise de la maladie de Newcastle est excellente : aucun cas de mortalité n'a été non plus rencontré pendant les 12 mois d'intervention (Tableau VII).

TABLEAU VII. COMPARAISON DES MORTALITES DES ADULTES AVANT ET APRES INTERVENTIONS. (DECEMBRE 2000 A NOVEMBRE 2001)

Causes	Mortalités			
	Après interventions		Avant interventions	
	nombre	%	nombre	%
NDV	0	0	78	75
Variole aviaire	0	0	0	0
Cholera aviaire	0	0	4?	3,8
Parasitisme	0	0	0	0
Voiture	14	58,3	10	9,6
Prédateur	1	4,2	1	0,96
Autres	9	3,5	11	10,6
Total	24	100	104	100
Taille du cheptel	303		331	

La voiture est devenue le premier facteur de mortalité de cette classe. Ce qui n'était pas étonnant car, deux villages sur trois sont traversés par une route goudronnée dans la zone 2.

Résultat économique

Sans interventions, chaque ménage gagne annuellement l'équivalent d'une somme égale à 12,68 US$. Ce revenu s'est élevé à 33,01 US$ l'année (revenu brut), suite à la vaccination anti-maladie de Newcastle et au déparasitage des poussins sous mère (Tableau VIII).

TABLEAU VIII. RESULTATS D'EXPLOITATION AVANT ET APRES INTERVENTIONS.

Période	Nombre de volailles exploitées	Valeur totale En FMG*	En US$	Revient par Famille Nbre de têtes	En FMG	En US$
Avant interventions	231	2.474.000	380,62	7,7	82.466	12,68
Après interventions	718	7.510.000	1155,38	20,5	214.571	33,01

* : FMG : franc malgache garanti (monnaie locale)

Le tableau financier a fait sortir des bénéfices égaux à 18,33 US$ et un rapport bénéfice sur charges (return) égal à 9,16 (Tableau IX).

TABLEAU IX. RESULTAT FINANCIER DE L'EXPLOITATION APRES 12 MOIS D'INTERVENTION. (PAR FAMILLE)

REVENUS TIRES DE L'EXPLOITATION (US$)			CHARGES (US$)	
COÛT DE LA PARIE EXPLOITEE	Après interventions	33,01	Coût du vaccin	1,32
	Avant interventions	12,68	Frais divers	0,32
			Médicament anti-parasitaire	0,35
DIFFERENCE		20,33	Charges totales	2,00
BENEFICE		18,33		
BENEFICE/CHARGES (Return)		9,16		

DISCUSSION

En intervenant sur les contraintes sanitaires majeures, à savoir la pseudo-peste aviaire et les parasitoses internes des poussins, la productivité extrinsèque de l'aviculture villageoise s'est trouvée fortement améliorée par rapport à la situation du départ. En effet, en mesurant les impacts de cette intervention en utilisant comme critères la variation du cheptel élevé, le taux d'exploitation et le taux de mortalité, les résultats obtenus se sont montrés positifs.

Concernant le cheptel élevé, une augmentation d'environ +49% a été réalisée pour une période d'une année. Ce résultat semblait être relativement modeste, en la comparant avec celle réalisée par Alders en 2002 au Mozambique (+140% l'année) avec la seule vaccination anti-Newcastle [3].

En se référant sur la partie exploitée, le chiffre correspondant, ramené par ménage, a connu une augmentation spectaculaire car elle est passée de 7,7 volailles par ménage au début des interventions à 20,5 à la fin du suivi, soit une hausse de plus de 166%. Cette hausse très importante du taux d'exploitation expliquerait la différence entre nos résultats et ceux de Alders et coll. où le taux correspondant ne dépasserait pas les 10%. La stagnation relative du cheptel élevé a été sûrement liée à cette conduite choisie par les ménages ; une conduite qui avait comme avantage d'éviter le dépassement rapide de la capacité de charge de l'environnement réservé au cheptel de chaque ménage en retardant la surpopulation. Un deuxième avantage consistait à favoriser les revenus tirés de l'exploitation ou à améliorer quotidiennement l'alimentation du ménage, étant donné que les produits restaient disponibles tout au long de l'année. Ce mode d'exploitation pourrait être pris comme modèle de départ en attendant la résolution des facteurs autres que les contraintes sanitaires.

Si l'on comparait le nombre de volailles exploitées avec le cheptel du départ, il représentait plus de 97% du cheptel initial. Ce fort taux d'exploitation ne concernait pas uniquement le cas de Madagascar : un chiffre sensiblement identique a été rapporté par Mopate et ses collaborateurs en 1997 au Tchad [4]. Le même comportement des villageois vis-à-vis de l'exploitation de leurs volailles se rencontrait dans plusieurs autres pays d'Afrique comme en Centre Afrique [5], au Tchad [6], en Ethiopie [7], au Togo [8], au Mali [9].

Une répartition par classe d'appartenance de la partie exploitée a mis en évidence que le poulet constituait le principal produit de l'aviculture villageoise : plus de 87% du total sont issus de cette classe « poulette ». La répartition des volailles d'exploitation par destination a fait apparaître que les ménages préféraient un peu plus consommer (54,32%) que de vendre (44,57%) leurs produits. En réalité, la tendance dépend de la situation de nécessités des ménages. Ainsi, lors du précédent suivi, la destination a été en faveur de la vente [10].

Dans l'ensemble, la pression des contraintes sanitaires ciblées a fortement diminué. La baisse du nombre des victimes des deux maladies constituait un indice sérieux en faveur de l'efficacité des interventions. En considérant l'ensemble du cheptel, 5,5 % des mortalités totales (42/762) sont dues à la MN. L'incidence de cette maladie n'atteint plus que 1,2 % des effectifs totaux (toutes classes confondues). Ces victimes ont permis de prouver le passage de la maladie et le taux de prévalence obtenu relativement bas constituait une preuve supplémentaire de l'efficacité des vaccins utilisés [11,12,13,14].

Le choix d'un mode de vaccination n'a jamais été chose facile[4]. L'échec survenu chez les deux ménages, l'un à vaccin HB1 (le ménage 121), l'autre à vaccin Pestavia (le ménage 236) a démontré la particularité du milieu dans lequel évoluent les volailles villageoises et aussi la complexité du système et la difficulté dans l'adéquation du calendrier de vaccination en utilisant des vaccins anti-Newcastle à souches thermosensibles.

Pour le cas du ménage 121, la défaillance apparente du vaccin HB1 dans son élevage n'a pas été tellement surprenante, vu ses absences fréquentes et son irrégularité dans le suivi de ses volailles. Il est à peu près certain qu'une partie de son cheptel ne soit pas vaccinée ou du moins mal vaccinée, si bien que l'élevage n'a pas été protégé.

Quant au ménage 236, il est régulier et Fig. parmi ceux ayant acquis les meilleurs succès avec un cheptel avoisinant la centaine, renfermant une vingtaine de femelles adultes. L'introduction de la MN provoquant uniquement la mortalité des poussins et des poulettes signifierait que les vaccinations durant les descentes successives deux ou trois mois auparavant n'ont pas fait de prise. Les vaccins utilisés à ces occasions étaient probablement inactivés. La cause de cette inactivation n'a pas été connue de façon précise mais, un défaut de chaîne de froid a été fortement suspecté. En effet, cette période a coïncidé justement au moment où le « thermocooler » n'était pas disponible et à la place, une simple glacière a été utilisée.

La réduction de l'incidence des maladies parasitaires a été également remarquable chez les classes vulnérables (poussin/poulette), surtout à partir du moment où nous avons confié le calendrier de traitement aux ménages eux-mêmes. Ce résultat prouve qu'il est possible de maîtriser les parasitoses, du moins à court terme, grâce à l'utilisation des médicaments appropriés. Le protocole mérite toutefois d'être affiné, car le traitement systématique que nous avons conçu pourrait aboutir et même favoriser l'accoutumance de la population parasitaire vis à vis des produits utilisés.

L'existence d'une parasitose résiduelle chez les 10% victimes serait probablement le résultat de l'inadéquation du protocole d'utilisation des deux produits (un protocole conçu pour un traitement strictement préventif). En effet, le déparasitage a été réalisé en coïncidence avec les descentes, autrement dit, à des intervalles réguliers d'une fois par mois. Malheureusement, les éclosions des poussins ne suivaient pas cette régularité : elles pouvaient arriver à tout moment, en particulier le lendemain ou les quelques jours qui suivent notre passage. Entre temps, les couvées correspondantes se sont, non seulement infestées mais, se trouvaient déjà malades avant de recevoir leur premier traitement préventif. Par conséquent, il convient de réajuster le protocole de déparasitage, non plus en fonction des descentes mais, en fonction de l'éclosion des poussins.

La vaccination anti-Newcastle et le déparasitage interne des poussins ont amélioré de façon substantielle la productivité de l'aviculture villageoise. Les interventions effectuées ont engendré des bénéfices égaux à 9 fois la valeur des dépenses engagées, résultats similaires à ceux obtenus par BELL au Cameroun avec la seule vaccination anti-maladie de Newcastle [15]. Les revenus ménagers ont été multipliés par 2 fois et demie en 12 mois d'interventions. Nous signalons, toutefois, que la répartition de ces bénéfices n'est pas uniforme tout au long de l'année : elle varie en fonction des périodes. L'aviculture villageoise est une activité rentable. Toutefois, il faudrait tenir compte des facteurs, autres que ceux d'ordre sanitaire, pour un meilleur résultat.

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AVICULTURE VILLAGEOISE A MADAGASCAR: PRODUCTIVITE ET PERFORMANCE DE CROISSANCE

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Résumé

Les investigations complémentaires visant à confirmer et compléter les résultats socio-économiques et épidémiologiques de 1999-2000 ont été également orientées vers les études des paramètres de productivité. Dans l'ensemble, les valeurs déjà publiées ont été retrouvées à savoir, la production annuelle d'œufs de la poule de race locale, le nombre d'œufs disponible pour la consommation-vente, le nombre de couvées par an et le taux d'éclosion. D'autres paramètres ont été mesurés. Le rythme de ponte, par exemple, a été de « un œuf toutes les 36 heures » et la durée moyenne d'élevage d'une couvée par leur mère, de 3 mois environ (87 j). Le cycle de reproduction s'élevait a 126j. Enfin, les mesures pondérales ont donné des valeurs moyennes de 47g, 1,620 kg et 2,460 kg pour l'œuf, la poule et le coq de race locale respectivement. La vitesse de croissance des poussins reste très variable.

Abstract

VILLAGE POULTRY IN MADAGASCAR: PRODUCTIVITY AND PERFORMANCE OF GROWTH.

Complementary investigations on productivity parameters were carried out on 1999-2000, to confirm and complet the socio-economic and epidemiological results. Overall, the values for the annual production of eggs, the number available for consumption and sale, the number incubated and the hatchability rate agreed with already published results. Other parameters were mesured. One egg was laid every 36 hours and the average duration of rearing of a clutch of chicks was 87 days. The reproduction cycle was 126 days. Finally, the average weight of eggs, hens and cocks were 47g, 1.62 kg and 2.46 kg respectively. The rate of growth of chicks was very variable.

INTRODUCTION

La volaille est actuellement la plus importante ressource animale dans le monde où le cheptel aviaire a été estimé en l'an 2000, à quelques 14 milliards de têtes, selon la FAO. La production d'œufs et de viande de volaille occupe plus de 30% de la totalité des protéines animales consommées, et cette part ne cesse de croître [1]. Dans la plupart des pays en développement, plus de 80% du cheptel aviaire évolue dans le sou-secteur traditionnel. La poule de race locale, élevée en liberté constitue la principale espèce exploitée.

Les enquêtes socio-économiques et épidémiologiques menées en 1999-2000 dans deux zones écologiques (Ambohimangakely et Moramanga) sur l'aviculture villageoise ont permis de connaître quelques paramètres de performance et de productivité de la poule indigène malgache. Les résultats obtenus ont précisé que la poule locale pond annuellement une trentaine d'œufs en 3 couvées, à raison de 12 œufs par couvée. La taille du cheptel aviaire familial s'élevait à 11 têtes [2, 3, 4].

Les investigations ont été poursuivies afin d'apporter des précisions complémentaires sur les chiffres déjà publiés tout en apportant les valeurs correspondant à d'autres paramètres de productivité. Ces paramètres concernent le poids des adultes, le poids des œufs, le cycle de production de la poule, la performance de croissance des poussins et des poulets, etc…

La connaissance de la performance de productivité et de croissance de la poule de race locale constitue un élément important pour l'élaboration d'un programme d'amélioration du système, en vue de lui donner une place dans le développement du secteur rural.

MATERIEL ET METHODES

Les zones d'étude, la méthodologie et les protocoles suivis étaient les mêmes que ceux de l'enquête socio-économique [2] à savoir : visites périodiques, enregistrement sur des fiches et carnets de tous les évènements zoo-sanitaires (production d'œufs et de poussins, mortalité, exploitation). En ce qui concerne la croissance des poussins, des pesées mensuelles nous permettaient de relever, au fur et à mesure leurs poids.

RESULTATS

Les résultats et données obtenus proviennent des mêmes familles étudiées (33) réparties entre les deux zones.

Production d'oeufs

Durant les deux saisons (une saison sèche, du mois de mai 1999 au mois octobre 1999 et une saison humide, du mois de Novembre 1999 au mois de mai 2000), 2987 œufs ont été enregistrés pour 256 couvées. Sur la totalité, 2237 œufs ont été incubés et les 750 œufs restants étaient soit consommés soit vendus par les ménages suivis. Parmi les incubés ; 2023 œufs ont donné 1590 poussins (Tableau 1).

A partir de cette production totale, nous avons calculé la productivité moyenne d'une poule villageoise en terme de nombre d'œufs par couvée ou de couvées par poule ainsi que la production annuelle d'œufs par poule (Tableau 3).

TABLEAU I. PRODUCTION D'ŒUFS ET LEUR UTILISATION.

Saison	Zone	Nombre de menages	Nombre de poules	Nombre de couvees	Oeufs Produits	Oeufs Incubes*	Oeufs Eclos	Disp. Vente
Sèche								
Mai à	1	12	34	45	587/551	457/399	327	130
Octobre	2	18	51	79	929/874	730/693	584	199
1999	1+2	30	85	124	1516/1425	1187/1092	911	329
Humide	1	12	39	54	655	450/385	276	205
Nov.1999	2	18	57	78	816	600/546	403	216
à Mai 2000	1+2	30	96	132	1471	1050/931	679	421
Annuelle	1+2	30	-	256	2987/2896	2237/2023	1590	750

* : numérateur : nombre total d'œufs incubés ; dénominateur : nombre d'œufs parmi les incubés ayant donné des poussins

TABLEAU II. PRODUCTION D'ŒUFS PAR POULE ET PAR COUVEE.

SAISON	ZONE	OEUFS Par poule	Par couvée	Nombre de couvées par poule
	1	17,26	13,04	1,32
Sèche	2	18,21	11,75	1,54
(5 mois)	1+2	17,83	12,22	1,47
Humide	1	16,79	12,12	1,36
(7 mois)	2	14,31	10,46	1,37
	1+2	15,32	11,14	1,37

TABLEAU III. PRODUCTION ANNUELLE D'ŒUFS PAR POULE.

SAISON	ZONE	ŒUFS PAR POULE	NOMBRE DE COUVEES
Sèche	1	17,83	1,475
Humide	2	15,32	1,37
Annuelle	1+2	33,15	2,84

La production moyenne par poule est de 17,83 œufs en 1,47 couvées soit 12,22 œufs par couvée (saison sèche) et de 15,32 œufs en 1,37 couvées soit 11,14 œufs par couvée (saison humide); ce qui donne une moyenne générale de 11,7 œufs par poule et par couvée (Tableaux 2, 3 et 4, Fig. 1).

Par conséquent, une poule donne annuellement 33 œufs en 2,84 couvées (Tableau III).

Il est à remarquer que, environ 54% de la totalité des œufs sont produits pendant les 5 mois de saison sèche (juin à octobre) et que la production est certainement minimale car elle englobe en même temps celle de la nouvelle génération de poules survenues au cours de l'année.

Les œufs sont utilisés soit pour la consommation / vente soit pour la production de poussins (Tableau IV, Fig.1).

Taux d'éclosion: 78,6 %

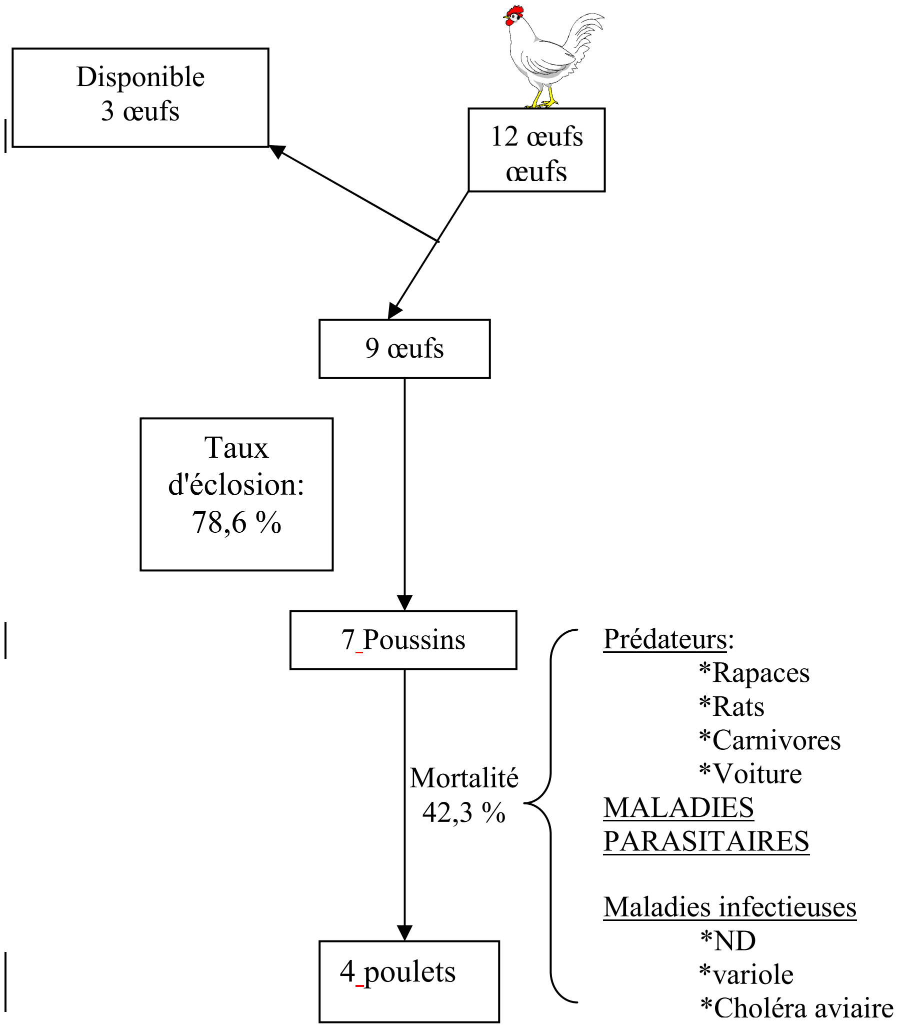

FIG. 1. Productivité moyenne par couvée de la poule villageoise malgache (zones 1et 2, projet MAG 10 185, 1999–2000)

TABLEAU IV. ŒUFS DISPONIBLES POUR CONSOMMATION/VENTE.

SAISON	ŒUFS Par couvée	Disponibles/couvée	Pourcentage/couvée
Sèche	2,22	2 ,65	21,68%
Humide	11,14	3,18	28,54%
Moyenne annuelle	11,66	2,92	25,04%

Une moyenne de 2,92 œufs par couvée soit 25% est réservée à la consommation/vente, ce qui correspond à environ 8 œufs par poule par an.

Le nombre d'œufs consommés / vendus par les ménages suivis est légèrement plus élevé pendant la saison humide comparé à celui de la saison sèche (Tableau IV).

Fertilité des œufs de poule de race locale

A partir des œufs incubés pendant les douze mois de suivi, nous avons pu calculé le taux d'éclosion moyen des œufs de poule locale dans les deux zones d'étude.

TABLEAU V. UTILISATION DES ŒUFS POUR LA PRODUCTION DES POUSSINS.

SAISON	OEUFS Par couvée	Incubés par couvée		Poussins éclos par couvée	Taux d'éclosion
Sèche	12,22	9,57	78,3%	7,98	83,42%
Humide	11,14	7,95	71,36%	5,79	72,93%
Moyenne annuelle	11,66	8,73	74,87%	6,86	78,59%

Les œufs sont surtout destinés à la régénération du cheptel : 75% environ de la production totale d'œufs sont utilisés pour la production des poussins. Au bout d'une année d'étude, le taux moyen d'éclosion observé est de 78,6% (Tableau V). Il est à remarquer qu'il existe une variation de ce taux au cours des saisons. Cette variation semble être en faveur de la saison sèche.

Cycle de reproduction de la poule villageoise

La productivité de la poule villageoise est également caractérisée par son cycle de reproduction qui comprend 3 phases:

- la ponte (avec son rythme)
- l'incubation et
- l'élevage des poussins.

Pour connaître la durée moyenne de ponte d'une poule villageoise, nous avons pu suivre 70 couvées. De ces couvées, nous avons pu calculer qu'une poule a besoin de 17,47 jours pour donner les 11,87 œufs d'une couvée; ce qui signifie, un œuf tous les 1,47 jours (Tableau VI).

TABLEAU VI. RYTHME DE PONTE.

ZONE	Nombre de couvees suivies	Nombre total d'oeufs	Duree d'une ponte (en jours)	Nombre d'œufs cal-cule/couvee	Rythme de ponte (en jours)
1	30	371	18,53 (± 6,20)	12,37(± 3,37)	1,51(± 0,40)
2	40	460	16,68(± 6,05)	11,50(± 3,35)	1,47(± 0,40)
1+2	70	831	17,47(± 6,10)	11,87(± 3,34)	1,47(± 0,39)

En utilisant la même méthode, en suivant 28 portées, la durée moyenne d'élevage des poussins par leur mère est de 87 jours (Tableau VII).

TABLEAU VII. DUREE D'ELEVAGE DES POUSSINS PAR LA MERE.

ZONE	MOYENNE (en jours)
1 (n=12)	83,08 (± 10,53)
2 (n=16)	90,36 (± 26,78)
1+2 (n=28)	87,00 (± 20,87)

TABLEAU VIII. CYCLE DE REPRODUCTION DE LA POULE DE RACE LOCALE.

Zone	Durée de ponte(j)	Durée d'incubation(j)	Durée d'élevage des poussins(j)	Cycle de production(j)	Nombre de couvées/an
1	18,53	21	83,08	122,61	2,97
2	16,68	21	90,36	127,98	2,85
1+2	17,47	21	87,00	125,47	2,9

(j : jours)

Connaissant la durée de ponte et celle de l'élevage des poussins par leur mère, nous avons pu calculer le cycle de reproduction de la poule de race locale malgache qui est d'environ 126 jours (125,47j). Par conséquent, la poule malgache donne annuellement 2,9 couvées (Tableau VIII), chiffre que l'on peut arrondir à 3 couvées par an. Ce qui confirme les résultats du suivi (2,84 ≈ 3).

Poids de l'œuf de poule villageoise

Après la mesure des différents paramètres de productivité de l'aviculture villageoise, nous avons également mesuré le poids des œufs de poule de race locale.

Comme résultat, un œuf pèse en moyenne 47 g. Signalons que les œufs de première couvée issus des poules à la première ponte sont plus légers avec un poids moyen de 44 g (Tableau IX).

TABLEAU IX. POIDS MOYEN D'UN ŒUF DE POULE DE RACE LOCALE.

Mère Poule	Poids d'un œuf (en g)
Au moins deux couvées (n=166)	47,84 (± 5,76)
Première couvée (n=42)	43,62 (± 5,27)
Sans distinction (n=208)	46,99 (± 5,90)

Comparaison de la poule villageoise malgache avec ses voisines africaines

Globalement, les paramètres de productivité de la poule villageoise malgache sont dans les limites africaines (Tableau X).

TABLEAU X. PLACE DE LA RACE LOCALE MALGACHE AU NIVEAU AFRICAIN

PAYS	COUVEES PAR AN	ŒUFS PAR COUVEE	POIDS D'UN ŒUF (g)	TAUX D'ECLOSIO N
Ethiopie [5]	-	-	44-49	39-42
Burkina Faso [6]	2,7-3,0	12-18	30-40	60-90
Tanzanie [7]	-	6-20	41	50-100
Ghana [8]	2,5	10	-	72
Mali [9]	2,1	8,8	34,4	69,1
Soudan [10]	4,5	10,87	40,6	90
Madagascar (Projet MAG 10 185)	2,84 (n=256)	11,66 (n=256)	46,99 (n=208)	78,6 (n=256)

Performance de croissance du poulet villageois

Période sous mère

Les poussins à l'éclosion pèsent en moyenne 31 g. Après trois mois, âge de séparation de la mère, ils pèsent environ 500 g d'où un gain moyen quotidien (GMQ) de 5,55 g. Lors des 21 premiers jours, la pente de la courbe de croissance est très faible, le GMQ n'est seulement que de 2,61 g. Par contre, pendant les 69 derniers jours, le gain de poids quotidien est de 6,00 g (Fig.2).

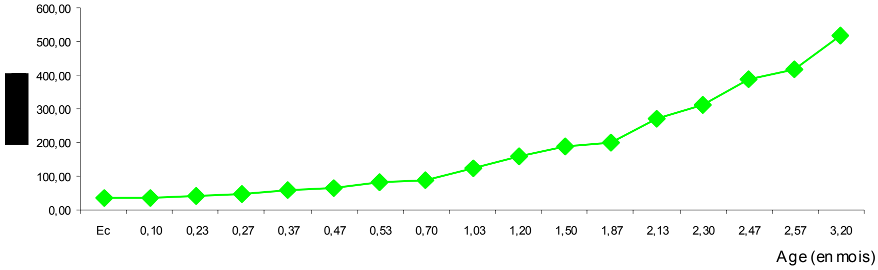

FIG.2. Mesures pondérales de croissance (Période sous-mère poule)

Période après séparation

A 7 mois d'âge, les poulets pèsent en moyenne 1500 grammes ; d'où un gain moyen quotidien de 7,14 g. Si l'on considère uniquement les 4 derniers mois après la séparation de leur mère, le GMQ est de 8,33 g (Fig.3).

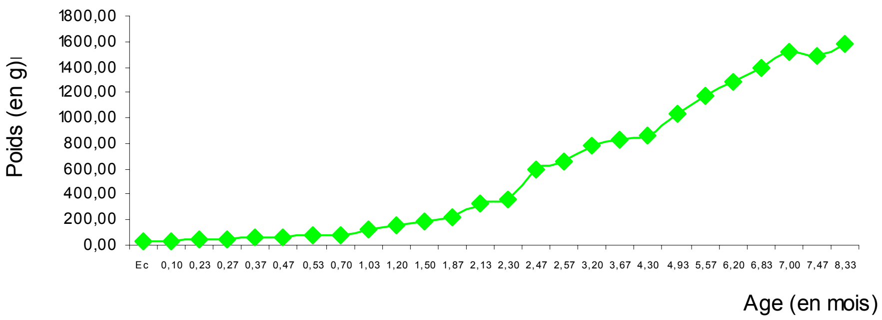

FIG.3. Mesures pondérales de croissance (jusqu'à sept mois d'âge)

Ces résultats s'expliqueraient par l'évolution de la capacité des poussins qui arrivent à se débrouiller de mieux en mieux en fonction de l'âge. Il faudrait également tenir compte de l'effet du groupe mère / poussins. En effet, à l'âge de séparation de leur mère, les poulets sont aptes à se débrouiller tout seul et trouvent plus de nourriture en évoluant chacun de son coté.

Poids des adultes

En ce qui concerne les adultes, le coq local pèse en moyenne 2,460 kg, tandis que la poule 1,620 kg. Cependant, les relevés de poids que nous avons effectués, montrent qu'il y a des spécimens allant de 600 g jusqu'à 2,450 kg pour les poules et 1,700 kg jusqu'à 4,010 kg chez les coqs; ce qui démontre une grande variabilité due probablement à l'existence des écotypes.

DISCUSSION

Les paramètres de production de la poule villageoise malgache que nous avions découverts lors de l'enquête socio-économique et épidémiologique ont été confirmés dans l'ensemble. Ce travail nous permettait de compléter nos études sur d'autres critères. Les valeurs trouvées cadrent bien dans les limites africaines. Le nombre d'œufs moyen par couvée, le rythme de ponte, le nombre de couvée par poule et par an, le taux d'éclosion, l'âge de séparation des poussins de leurs mères, la croissance des poussins et poulettes, le cycle de reproduction, le poids d'un œuf, le poids des adultes sont pratiquement les mêmes [1, 2, 3, 4, 11, 12].

L'hétérogénéité des adultes du point de vue poids, serait un indice en faveur de l'existence des écotypes [11], ce qui suppose une grande variabilité génétique de la race locale et par conséquent, des performances génétiques variées dont l'étude constitue certainement un axe de recherche incontournable pour l'amélioration de ce sous-secteur avicole traditionnel.

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IMPACTS DE L'AMELIORATION DE CONDUITE SUR LA PRODUCTIVITE DE L'AVICULTURE VILLAGEOISE A MADAGASCAR

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Résumé

Pour améliorer les impacts de la vaccination anti-maladie de Newcastle et le traitement anti-parasitaire des poussins sur la productivité de l'aviculture villageoise, une complémentation alimentaire des poussins sous mère et une vulgarisation d'abri ont été rajoutées durant les années 2002 à 2004. En ce qui concerne les abris, seules des améliorations étaient possibles, la construction d'un nouvel abri indépendant des habitations humaines étant fortement handicapée par la situation d'insécurité en milieu rural. Quant aux effets de la complémentation alimentaire, ils sont perceptibles beaucoup plus en terme de stabilité du gain moyen quotidien (GMQ) que de vitesse de croissance. Le taux de mortalité globale reste inchangé, conformément à l'intervention sanitaire seule. L'analyse économique de cette deuxième intervention a donné un rapport bénéfice sur charges égal à 3,2 indiquant que les dépenses occasionnées par la vaccination et le déparasitage des poussins couplés à la complémentation alimentaire et à la construction d'abri génèrent des bénéfices égaux à 3 fois sa valeur.

Abstract

IMPACT OF IMPROVED PRACTICES ON THE PRODUCTIVITY OF VILLAGE POULTRY FARMING IN MADAGASCAR.

To improve the impact of vaccination against Newcastle disease and anti parasite treatment of chicks on the productivity of village poultry production, additional feed was given to chicks with their mother and a simple shelter was added during the years from 2002 to 2004. Regarding the shelters, only improvements were possible given that the construction of a new shelter away from human habitation was strongly contraindicated by the rural security situation. As for the effects of supplementary feed, they are much more noticeable as stability of the daily mean weight gain rather than growth rate. The economic analysis of this second intervention gave a benefit cost ratio of 3.2, indicating that the cost of vaccination and parasite treatment coupled with supplementary feeding and the construction of shelter gave a benefit equal to three times its value.

INTRODUCTION

La maîtrise des principales contraintes sanitaires obtenue pendant la première phase de nos interventions a permis de réduire très nettement la mortalité chez toutes les classes d'âge. Il en résulte une augmentation du cheptel élevé et en particulier de l'effectif exploité. Toutefois, une mortalité résiduelle relativement importante demeure constatée en particulier chez les poussins où l'on enregistre encore annuellement quelque 29,3% de pertes jusqu'à l'âge de séparation de la mère [1]. Cette persistance de mortalité sous-entend la présence des facteurs, autres que les contraintes sanitaires [2, 3, 4]. En effet, la multiplicité des contraintes est une des caractéristiques fondamentales de l'aviculture traditionnelle dans les pays africains [5]. En dehors des pathologies diverses, le mode d'élevage constitue également un facteur limitant non négligeable de la productivité de l'aviculture villageoise. L'absence d'abri, par exemple, expose les volailles à la merci des prédateurs [6], des intempéries, etc.

alors que la capacité limitée de la nature en ressources alimentaires entraîne des carences chroniques en éléments nutritifs aboutissant ainsi à des retards de croissance considérables et même à des mortalités chez les classes les plus vulnérables [7, 8, 9].

La deuxième phase d'intervention se propose de vulgariser la construction d'abri au niveau de chaque ménage et d'apporter une complémentation alimentaire uniquement aux poussins sous mère.

MATERIEL ET METHODES

Zones d'étude et action sanitaire

Les zones, les villages et les ménages dans lesquels a été menée l'expérimentation, sont globalement les mêmes que ceux des interventions antérieures [1]. La vaccination anti-maladie de Newcastle et le déparasitage des poussins sous mère sont continués et appliqués selon le protocole de la première intervention [10].

Construction d'abris

L'objectif consiste à construire des abris simples, économiques en utilisant des matériaux locaux afin de préserver l'hygiène dans les habitations humaines tout en évitant la promiscuité.

Complémentation alimentaire

Il s'agit d'apporter un peu d'aliment énergétique aux poussins sous mère en complément de ce qu'ils peuvent trouver dans la nature.

L'aliment que nous avons proposé est un mélange de maïs broyé (70%) et de son fin de riz (30%). Chaque poussin reçoit 10g de ce mélange quotidiennement quel que soit l'âge jusqu'à la séparation de la mère. Chaque ménage devrait construire un isoloir dans lequel les poussins vont recevoir leur aliment complémentaire. Des pesées mensuelles ont permis de suivre l'évolution de leurs poids respectifs en fonction de l'âge.

Analyse économique

L'analyse économique permet de voir la rentabilité, ou non, des interventions entreprises. Il s'agit donc de comparer les coûts de production aux revenus générés.

RESULTATS

Abri

Notre action se limitait plutôt à des propositions d'amélioration des abris existants : la construction d'aménagements indépendants, séparés totalement des habitations humaines étant sérieusement compromise, vu la situation d'insécurité, en particulier en milieu rural.

Plusieurs types ont été rencontrés:

Construction d'abri, indépendant de la maison d'habitation :

Ce type est de moins en moins possible. Actuellement, il est même à déconseiller. Un seul ménage a pu construire ce modèle d'abri pour ses volailles grâce à un environnement favorable (présence d'enceinte): cas du ménage 214

Un deuxième ménage a également profité de la situation favorable offerte par la présence d'une clôture, bien avant nos interventions : il s'agit du ménage 217.

Malheureusement, ayant été victime d'un cambriolage en novembre 2000, le ménage 217 s'est momentanément désintéressé de toute proposition d'amélioration de cet abri traditionnel.

Construction d'un abri type mais toujours collé à la maison d'habitation du propriétaire :

- avec une (des) ouverture(s) indépendante(s) : cas des ménages 111, 112, 213, 223, 224 et 236
- avec une ouverture dans la chambre d'habitation (ou cuisine), cas du ménage 222

Construction d'un abri à l'intérieur d'une cuisine ou d'une chambre d'habitation

- avec condamnation de la chamber, cas du ménage 232
- avec utilisation simultanée de la cuisine ou de la chamber, cas des ménages 131, 235 et 2310 et 234

Construction d'abri dans un magasin

- cas des ménages 113, 126 et 226

Construction d'abri sous l'escalier

- cas des ménages 116, 114 et 237
- sans abri particulier : hébergement des volailles directement :
  - dans une cuisine
  - cas des ménages 115, 123, 127, 225 et 227
  - dans une chambre d'habitation
  - cas des ménages 215, 229 et 233

Complémentation alimentaire

Composition chimique de l'aliment complémentaire

L'analyse physico-chimique de l'aliment complémentaire expérimental a donné 9,7% de protéine brute et 8,1% de matières grasses (Tableau I).

TABLEAU I. ANALYSE PHYSICO-CHIMIQUE DE L'ALIMENT COMPLEMENTAIRE.

Eléments analysés	Teneur en % par rapport au produit brut	Teneur en % par rapport à la matière sèche
Humidité	8,3	-
Matière sèche	91,7	100
Protéine brute	9,7	10,5
Matières grasses	8,1	8,83
Cellulose brute	4,3	4,68

Impact sur la croissance des poussins

Les relevés de poids des poussins avant ou pendant la complémentation alimentaire ont été rassemblés et présentés sous forme de courbes. Pour la saison humide, les deux courbes de tendance se séparent dès les premiers jours et la différence est à l'avantage de la complémentation alimentaire (Fig.1). Par contre, pour la saison sèche, les deux courbes se superposent, pendant toute la durée de vie des poussins avec leurs mères. Toutefois, vers la fin de la vie commune du couple mère/poussins, les deux courbes se sont séparées petit à petit; l'écart qui se creusait au fil des âges (jusqu'à 125 jours), semble être au profit de la situation sans complémentation. En effet, l'allure de la courbe semble démontrer que l'aliment complémentaire a provoqué un effet inverse, autrement dit un ralentissement de croissance (Fig.2).

En se référant aux courbes des gains moyens quotidiens (GMQ), la comparaison montre une très grande variabilité des valeurs obtenues en absence de complémentation alimentaire:

- des parties où la courbe des GMQ est croissante, correspondant à des périodes favorables pendant lesquelles le gain moyen peut aller jusqu'à 9,8g (TAB. II, Fig. 3).
- d'autres parties où la courbe reste stationnaire ou franchement décroissante indiquant des périodes difficiles où l'on assiste à des pertes de poids (GMQ à valeur négative).

En apportant une complémentation alimentaire aux poussins:

- la courbe de variation des GMQ est beaucoup plus rectiligne, montrant ainsi une croissance plus homogène et plus soutenue, moins entrecoupée. Le GMQ des poussins sous mère reste croissant depuis l'éclosion jusqu'à l'âge de séparation de la mère (Tableau II).
- à 3 mois, l'apport d'aliment complémentaire est stoppé (l'âge de séparation moyen des poussins de leur mère étant de 87 jours dans la situation de référence, c'est-à-dire, avant la complémentation). A cette période précise, le GMQ chute de 8,2g à 2,15g, mais remonte peu à peu pour atteindre et même dépasser le GMQ maximal obtenu (8,2g) pendant l'apport alimentaire en 45j post-séparation (Tableau.II, Fig.3).

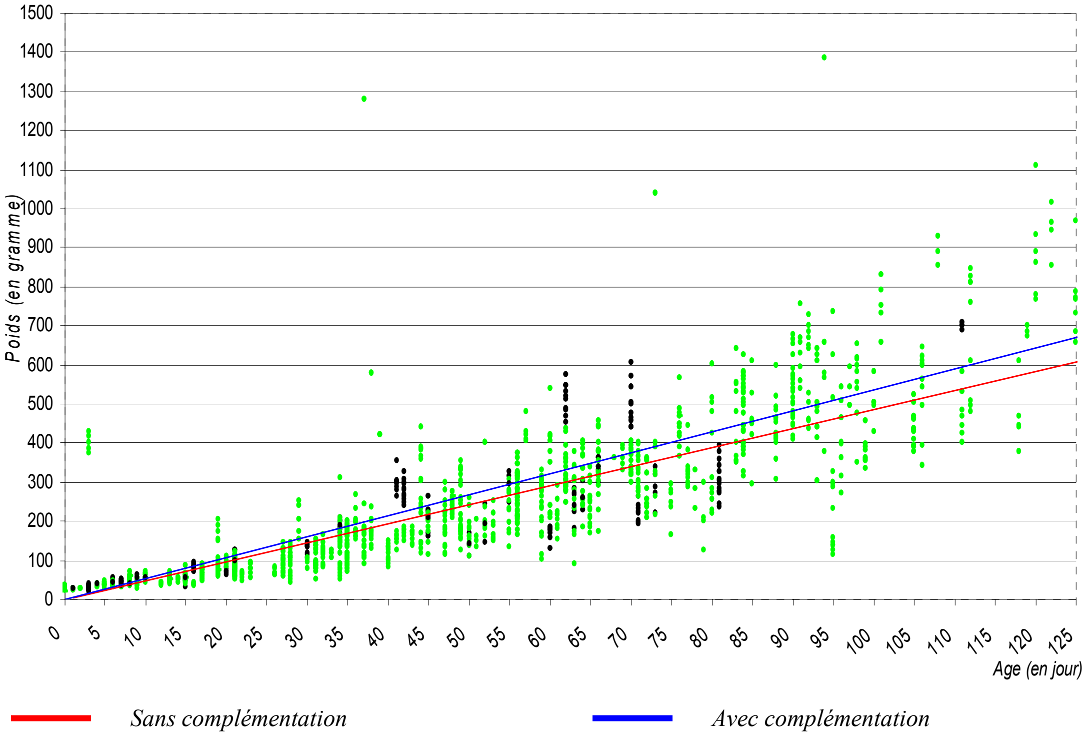

FIG. 1. Courbe d'évolution de poids des poussins (saison humide)

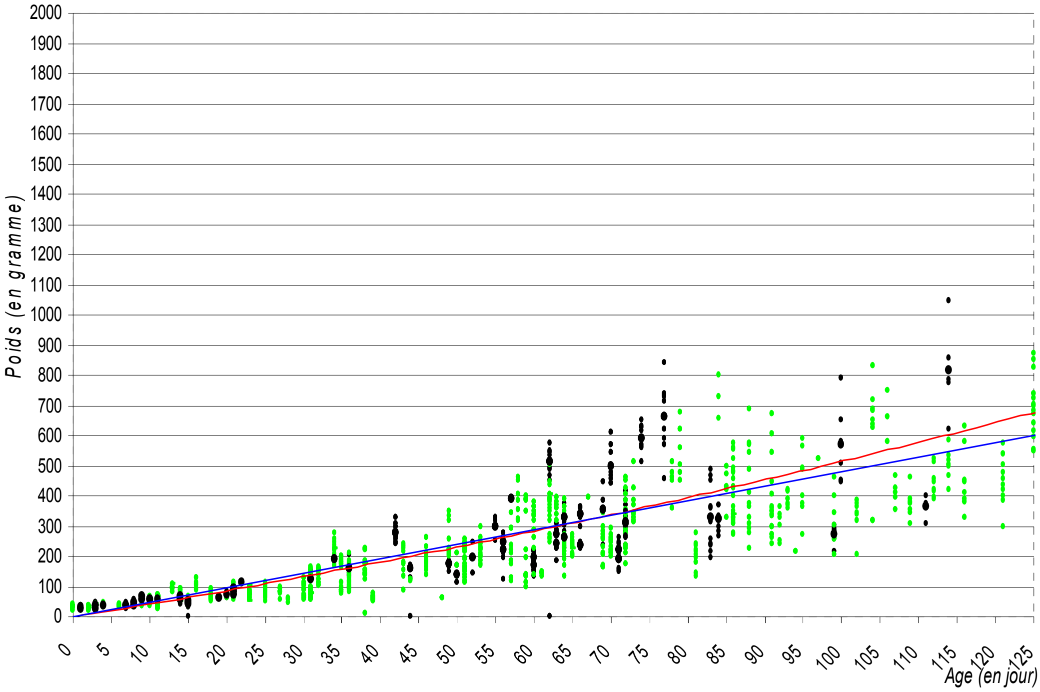

FIG. 2. Courbe d'évolution de poids des poussins (saison sèche)

TABLEAU II. EVOLUTION DES GAINS MOYENS QUOTIDIENS.

Age (en mois)		Ec-0,5	0,5-1	1-1,5	1,5-2	2-2,5	2,5-3	3-3,5	3,5-4	4,5-5
GMQ (g/j)	Sans Complé-mentation	0,83	3,08	7,4	-0,01	9,8	7,8	-4,9	14,8	9,34
	AvecComplé-mentation	0,95	3,15	4,25	5,4	6,2	8,26	2,15	7,15	7,65

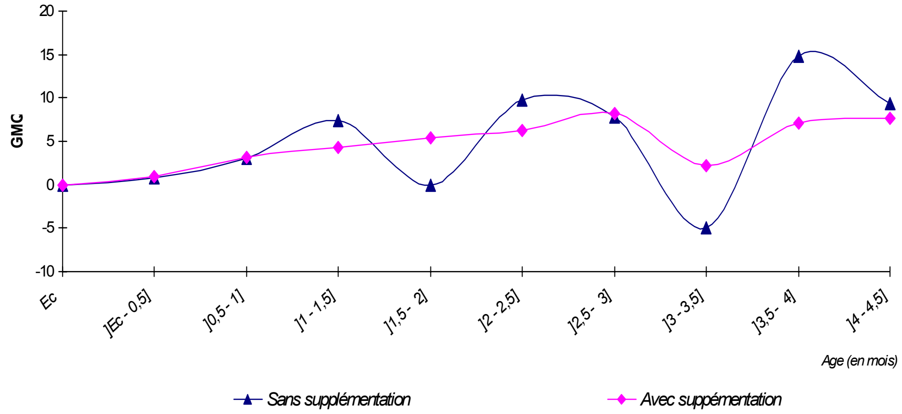

FIG. 3. Courbe d'évolution des GMQ

Evolution des effectifs

Effectif élevé

Le nombre de ménages a beaucoup diminué : il est passé de 35 à 21 familles seulement. Des ménages ont abandonné en cours de route, par manque de motivation. Ce phénomène a été surtout constaté dans la zone 1 où nous n'avions plus que deux familles dans le village 12 et une famille unique dans le village 13.

Pour la zone 2, les abandons faisaient plutôt suite à des évènements liés à l'insécurité; d'ailleurs, des nouveaux ménages se sont ralliés à nous pour pouvoir profiter des activités du projet.

A partir du tableau des mouvements d'effectifs des deux zones, nous avons pu calculer facilement les paramètres suivants (Tableau III) :

- le cheptel élevé semble se stabiliser : en une année, un accroissement de +3,5% seulement a été enregistré.
- le nombre de poules par ménage passe de 2,4 (mai 1999)) à 8, actuellement (avril 2004) en passant par 6,5 (mai 2003).
- le sexe ratio a fortement changé : il est actuellement de 1 coq pour 6,2 poules alors qu'il était de 1 coq pour 3,6 poules en 1999 (au moment de l'enquête transversale). Nous signalons qu'il restait sensiblement le même au début de l'exercice (mai 2003) avec 1 coq pour 4 poules.
- le cheptel aviaire moyen familial n'a toutefois cessé d'augmenter de façon remarquable : il était de 11 têtes par ménage au début du projet, s'élevait à 31 à la

fin de la première intervention et atteignait 36 à la fin de la deuxième intervention (avril 2004).

TABLEAU III. MOUVEMENT DES EFFECTIFS. (ZONES 1 ET 2)

Paramètres	Classe C	Classe G	Classe AF	Classe AM	TOTAL
Effectif initial (mai 2003)	321	247	137	33	738
Poussins neufs	1481	-	-	-	
Mortalités	646	40	12	1	699
Perte	37	17	2	1	57
Achat	0	7	0	0	7
Sortie (transfert)	745	95	-	-	-
Entrée (transfert)	-	745	81	14	832
Entrusted in	12	10	2	3	27
Entrusted out	12	12	4	0	28
Exploitation	20	631	34	21	706
Effectif final (avril 2004)	354	215	168	27	764

Effectif exploité

Pour la partie exploitée, il a été confirmé, une fois encore, que le poulet est le produit principal : plus de 89% des volailles exploitées sortent de cette classe (Tableau IV).

TABLEAU IV. RECENSEMENT DU CHEPEL EXPLOITE.

Classe	Classe C	Classe G	Classe AF	Classe AM	TOTAL	Pourcentage
Vendu	13	419	7	4	443	62,8
Consommé	7	209	27	17	260	36,8
Don	0	3	0	0	3	0,4
TOTAL	20	631	34	21	706	100
Pourcentage	2,8	89,4	4,8	3,0	100	-

Lors de l'exercice antérieur, la consommation l'emportait sur la vente. Pour cette année, la vente a largement dominé la consommation en absorbant plus de 62% de la totalité de l'effectif exploité. La conduite adoptée par les ménages reste inchangée : le taux d'exploitation enregistré s'élève à environ 96% par rapport à l'effectif initial (706/738) (Tableau III).

Mortalité

Mortalité globale

Le taux de mortalité global obtenu à la suite de cette deuxième intervention est du même ordre que celui de la première (22,8% contre 21,07%) avec, toutefois, une nette diminution des mortalités de la classe adulte et de la classe poulette et une apparente augmentation de la mortalité de la classe poussin (35,8% contre 29,3%) (Tableau V).

TABLEAU V. TAUX DE MORTALITE GLOBAL ET PAR CLASSE.

	Classe poussin (C)	Classe poulette (G)	Classe adulte (AF/AM)	TOTAL
Effectif total (n)	1802	992	265	3059
Mortalité	646	40	13	699
Pourcentage	35,8	4,0	4,9	22,8

Analyse des mortalités

L'analyse des causes de mortalité montre également les mêmes résultats que ceux de la première intervention à savoir, la dominance des facteurs « autres », l'absence de grandes épidémies attribuables à la pasteurellose, la présence des maladies parasitaires et de la variole touchant principalement la classe « poussin » (Tableau VI).

TABLEAU VI. REPARTITION DES MORTALITES PAR CAUSE.

Causes des mortalités	Classe C	Classe G	Classe AF	Classe AM	TOTAL
NDV	0	0	0	0	0
Variole	25	0	0	0	25
Pasteurellose	0	0	0	0	0
Parasitisme	196	0	0	0	196
Voiture	9	16	3	0	28
Prédateur	80	3	1	1	85
Autres	336	21	8	0	365
TOTAL	646	40	12	1	699

Analyse économique

La complémentation alimentaire et la construction d'abri, couplées à la vaccination anti-maladie de Newcastle et le déparasitage des poussins engendrent des bénéfices égaux à 3,2 fois la valeur des dépenses engagées (Tableaux VII et VIII). Le revenu du ménage se trouve multiplier par 3 fois et demie (3,6).

TABLEAU VII. RESULTATS D'EXPLOITATION AVANT ET APRES INTERVENTIONS.

Période	Nombre de volailles	Valeur estimée FMG*	Valeur estimée US$	Revient par famille Nombre	Revient par famille en FMG	Revient par famille en US$
Avant Interventions	231	2.474.000	380,62	7,7	82.466	12,68
Après Interventions	706	11.145.000	1177,31	33,62	530.714	56,06

* FMG, franc malgache garanti (monnaie locale)

TABLEAU VIII. RESULTAT FINANCIER DE L'EXPLOITATION APRES 12 MOIS D'INTERVENTION. (PAR FAMILLE)

REVENUS TIRES DE L'EXPLOITATION (US$)			CHARGES (US$)	
COÛT DE LA PARIE EXPLOITEE	Après interventions	56,06	Coût du vaccin	0,41
			Frais divers	0,61
	Avant interventions	12,68	Médicament anti-parasitaire	0,24
			Coût abri	2,11
			Complémentation	6,96
DIFFERENCE		43,38	Charges totales	10,32
BENEFICE		33,05		
BENEFICE/CHARGES (Return)		3,20		

DISCUSSION

Pour la plupart des éleveurs, les abris ont été déjà existants et seulement améliorés. La stratégie globale adoptée par les ménages dans la construction et la mise en place de ces abris tend toujours vers le rapprochement des volailles de leurs habitations. Ce phénomène est fortement lié à la situation d'insécurité qui, depuis ces dernières années, s'enracine de plus en plus dans le milieu rural.

L'aliment complémentaire apporté aux poussins renferme 9,7% de protéine brute, protéine totalement d'origine végétale. De la naissance à 3 mois d'âge, la teneur normale en matière azotée brute (MAB) d'une ration équilibrée des poussins tourne atour de 20%. Cette ration est distribuée quantitativement à raison de 10g par jour et par individu pendant la première semaine ; quantité qui sera augmentée jusqu'à 65g au début de la 12^{e} semaine [11,12]. Ainsi, la ration complémentaire expérimentale n'apporte qu'environ la moitié des besoins protéiques de la première semaine d'âge du poussin, sans compter l'absence des protéines d'origine animale. Dans ces conditions, il est évident que le poussin reste, dans une large mesure, dépendant des ressources alimentaires offertes par la nature.

La courbe de croissance témoin fait ressortir que nos poussins traversaient apparemment deux périodes critiques : la première, pendant la quinzaine qui suit le premier mois d'âge et la seconde, la quinzaine qui suit le 3^{e} mois d'âge autrement dit, le moment de séparation de la mère.

Etant donné que la croissance est une fonction directe de l'alimentation, cette variabilité de l'aspect de la courbe obtenue traduit à première vue la variabilité de la disponibilité des aliments offerts par la nature (alternance des périodes d'affluence et des périodes de disette). Dans notre situation où la complémentation alimentaire n'apporte pas la totalité des besoins nutritionnels des poussins, les ressources alimentaires de base (SFRB pour scavenging food resource base) jouent un rôle très important dans la possibilité de correction [7, 8]. Les deux périodes critiques sont certainement liées au déficit alimentaire de base.

Si, dans la situation d'avant complémentation, la première période critique nous est difficile à expliquer, la seconde est certainement liée à cette séparation de la mère pendant laquelle les nouveaux poulets acquièrent leur totale indépendance et sont contraints à se débrouiller seuls. L'aide maternelle étant stoppée, ils ont du mal à s'y adapter et à mettre à profit cette indépendance. Apparemment, cette déroute ne dure qu'une quinzaine de jours car, ils arrivent déjà à doubler (14,8g) le dernier GMQ en compagnie de leur mère (7,8g) lors de la deuxième quinzaine suivant la séparation.

Avec une complémentation alimentaire, la crise du premier mois d'âge semble avoir complètement disparu; celle de l'âge de séparation de la mère persiste mais avec une intensité fortement réduite. La disparition de la première période critique et cette réduction des effets de la séparation sous la complémentation est un indice sérieux en faveur de l'importance du facteur alimentaire pour expliquer le phénomène. L'aliment complémentaire permet aux poussins de garder une courbe de croissance beaucoup plus linéaire autrement dit, moins en dents de scie.

Toutefois, la vitesse de croissance semble ne pas être significativement améliorée. En effet, l'évolution du poids des poussins, de l'éclosion à la séparation de la mère est à priori, de même ordre de grandeur.

La stagnation relative du cheptel caractérise la conduite adoptée par les ménages : ils préfèrent d'emblée exploiter les moindres résultats plutôt que de laisser grossir le cheptel [9]. Cette attitude est dictée par la situation de nécessité permanente des ménages et/ou par la situation d'insécurité en milieu rural.

L'amélioration du sex ratio qui se traduit surtout par l'augmentation du nombre des femelles adultes est un témoin d'une meilleure exploitation des coqs en faveur de la préservation des femelles. [13]. Ce choix semble être logique dans la mesure où, dans une même portée, le mâle a toujours une croissance plus rapide et par conséquent, atteint l'âge commercial avant la femelle.

Une fois encore, le taux d'exploitation par rapport à l'effectif du départ s'est montré très élevé (96%) où la classe poulette représente plus de 89% des volailles exploitées. Ces résultats concordent parfaitement à ceux de la première intervention. L'analyse des mortalités a donné des résultats globaux plus ou moins identiques à ceux de l'intervention sanitaire [10].

Toutefois, la classe « poussin » reste toujours la première victime avec un taux de mortalité légèrement augmenté (35,8% contre 29,3%). L'augmentation du taux de mortalité des poussins est due au facteur « autres » qui, rappelons-le, regroupe lui-même un certain nombre de facteurs tels que le piétinement, l'égarement, les accidents divers, les facteurs climatiques (vent, température, pluie, etc…). Cette élévation serait liée à la sévérité des conditions climatiques que traversait Madagascar l'année 2004 où deux cyclones tropicaux se sont relayés en l'espace d'une semaine.

L'analyse économique de cette deuxième intervention a indiqué un coût plus élevé (10,32 US$) par rapport à la première (2,00 US$) et par conséquent, un rapport bénéfice sur charges (*return*) fortement réduit. Mais le revenu se trouve toutefois multiplié par 3 fois et demie, ce qui rejoint les résultats de BELL avec la vaccination anti-maladie Newcastle seule [14]. Il faut remarquer que la complémentation alimentaire occupe à elle seule plus de 67% des coûts de revient des interventions.

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AVICULTURE VILLAGEOISE A MADAGASCAR: ENQUETE EPIDEMIOLOGIQUE

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Résumé

Pour compléter les données socio-économiques et épidémiologiques réalisées entre 1999 et 2000, d'autres investigations visant à confirmer les résultats, ont été menées. Ainsi, le virus de la maladie de Newcastle, maladie reconnue comme étant la première contrainte sanitaire du sous-secteur avicole traditionnel, a été isolé et identifié. Par des études sérologiques, des anticorps spécifiques contre un certain nombre de maladies ont été également détectés. Il s'agit de la bronchite infectieuse, de la maladie de Gumboro et de la salmonellose à *Salmonella pullorum* dont la séroprévalence s'élève à 96%, 64% et 1,77% respectivement.

Abstract

VILLAGE POULTRY IN MADAGASCAR: EPIDEMIOLOGICAL SURVEY.

To complete the socio-economic and epidemiological data obtained between 1999 and 2000, other investigations aiming to confirm the results were carried out. Thus, Newcastle disease virus, recognised as the first health constraint in the traditional avian sub sector, was isolated and identified. Through serological studies specific antibodies against a number of diseases were detected. The seroprevalence of infectious bronchitis, Gumboro disease, and *Salmonella pullorum* was 96%, 64% and 1.77% respectively.

INTRODUCTION

Les enquêtes socio-économiques et épidémiologiques effectuées entre 1999 et 2000 ont révélé la faiblesse de la productivité du système et la place des contraintes sanitaires parmi les principaux facteurs limitants de l'aviculture villageoise. La lutte contre les pathologies dominantes (vaccination anti-Nawcastle et déparasitage interne des poussins sous mère, ont permis de réduire de façon significative les mortalités au niveau de chaque classe.

Toutefois, une mortalité résiduelle relativement importante persiste, en particulier chez les poussins où l'on enregistre encore annuellement quelques 29,3% de pertes jusqu'à l'âge de séparation de la mère [1]. Cette persistance de mortalité témoigne la présence des facteurs autres que les maladies ciblées. En effet, la multiplicité des contraintes est une des caractéristiques fondamentales de l'aviculture traditionnelle dans les pays africains. Pour Madagascar, en dehors des pathologies classiques composées de la maladie de Newcastle, de la variole et de la pasteurellose, plusieurs autres maladies aviaires d'origine virale font actuellement l'objet de vaccination dans le sous-secteur avicole commercial. Leur présence et leurs impacts dans l'aviculture villageoise locale restent très mal connus. En se servant des examens histologiques doublés d'un diagnostic virologique, Rajaonarison et son équipe, en 1993, ont mis en évidence, pour la première fois, l'existence de la maladie de Gumboro dans le grande Ile [2]. Par des études sérologiques, Porphyre, en 1999, a signalé par la suite, la présence de la BI, de la maladie de Gumboro, de l'encépholomyélite aviaire chez le poulet villageois [3]. Les observations cliniques faites durant toute la durée du projet ne nous permettant de tirer aucune conclusion, une étude sérologique a été effectuée pour la recherche de la bronchite et de la bursite infectieuses. Enfin, en ce qui concerne la maladie de Newcastle, des essais d'isolement du virus ont été entrepris pour renforcer les résultats d'autopsie et de diagnostic sérologique réalisés pendant la phase d'enquête.

MATERIEL ET METHODES

Isolement et identification du virus de la maladie de Newcastle (NDV)

Prélèvements d'organe et/ou de liquide biologique

Deux sortes de prélèvement ont été faites pour isoler le virus Newcastle au moment des épidémies:

- la tête des volailles malades coupée après autopsie
- du liquide cloacal ou trachéal prélevé au sein d'un individu convalescent présentant encore des séquelles de maladie de Newcastle à l'aide du coton stérile, dont le milieu de transport est constitué par du milieu de culture cellulaire (MEM) additionné d'antibiotiques (pénicilline – streptomycine).

Cellules BSR

Les cellules BSR (clone des cellules BHK_{21}) sont cultivées dans des flacons plastiques Falcon de 25 cm2 dans du milieu MEM Eagle (SIGMA) additionné de sérum de bovin (5 à 10%) et d'une solution antibiotique (pénicilline 100 UI par ml et streptomycine 100µg par ml).

Pour isoler le virus NDV, les prélèvements cloacaux ou trachéaux sont inoculés directement sur cellules BSR. Pour la tête, le cerveau est prélevé stérilement, broyé au 1/10^{e} dans une solution antibiotique (pénicilline 100 UI par ml v/v, streptomycine 100µg par ml p/v). La suspension d'organe ainsi obtenue est clarifiée avec un filtre Millipore 0,45µm puis inoculée également aux cellules BSR. Une lecture quotidienne au microscope permet de suivre l'évolution de la culture et de détecter l'apparition éventuelle d'une lyse spécifique des Paramyxovirus (syncitium).

Après 3 jours d'incubation à 37°C, les cellules inoculées sont congelées à –20°C, décongelées et centrifugées à 3000 rpm. Seul le surnageant de culture cellulaire fait l'objet d'une récolte. Des passages supplémentaires sont souvent nécessaires pour confirmer l'isolement, en adaptant le virus. En cas de lyse cellulaire, le pouvoir hémagglutinant du surnageant de culture est testé en présence d'une suspension d'hématies de coq (0,5% dans de l'eau physiologique 0,85%). Ensuite, en cas des résultats positifs, le virus hémagglutinant subit le test IHA pour son identification en se servant du sérum positif de référence : une suspension de virus contenant 4 UHA est mélangée à une série de dilution de 2 en 2 de l'antisérum [4].

Plaques de microtitration

Les plaques utilisées sont des plaques de 96 puits à fond U et à faible capacité d'absorption de protéines (NUNC). Elles servent à titrer le pouvoir hémagglutinant des isolats et à les identifier par le biais du test IHA ou test d'inhibition de l'hémagglutination.

Réactifs

Pour identifier les virus isolés, un sérum de référence anti-Newcastle, souche Lasota (Animal Health Service) a été utilisé.

Recherche de Salmonella

Elle a été réalisée par application de la technique d'agglutination rapide sur lame (ARL) sur des plaques en porcelaine : une goutte de sérum mélangée avec une goutte d'antigène. L'antigène utilisé est l'antigène *pullorum* (LSI).

Dosage des anticorps anti-bursite et anti-bronchite infectieuses

Les dosages d'anticorps anti-maladie de Gumboro et des anticorps anti-bronchite infectieuse ont été confiés au Laboratoire de la Maison du Petit Elevage (MPE). Les tests ont été réalisés en utilisant des Kits ELISA (CIVTEST™ - HIPRA). Les titres anticorps correspondants ont été calculés en utilisant les formules mentionnées dans les notices accompagnant les Kits.

RESULTATS

Isolement du virus de Newcastle

Inoculation sur cellules BSR

Cinq prélèvements ont pu être traités : 3 cerveaux (numérotés C1, C 2 et C3), un liquide cloacal (LC1) et un liquide trachéal (LT1). Tous les inocula ont provoqué des arrondissements de cellules au premier passage, mais seuls le cerveau n°2 (C2) et le liquide trachéal (LT1) se sont montrés réellement positifs jusqu'au 3e passage (Tableau I).

TABLEAU I. ISOLEMENT DES SOUCHES SAUVAGES NDV SUR CELLULES BSR.

Origine du prélèvement	N° de Code	Lecture au microscope		
		1er passage*	2e passage	3e passage
	C1	+	-	-
Cerveau	C2	++	+++	+++
	C3	+	-	-
Liquide trachéal	LT1	-	-	-
Liquide cloacal	LC1	+	+	+

* : signe + indique la présence de lyse, signe – indique l'absence de lyse

Le C2 lyse totalement les cellules au bout de 48 à 72 heures d'incubation. Par contre, le LC1 ne provoque qu'une lyse débutante: il nécessite peut-être d'autres passages d'adaptation (Tableau I).

Titrage du pouvoir hémagglutinant des isolats.

Tous les surnageants de culture cellulaire inoculée ont été titrés en présence du virus témoin Pe (souche Mukteswar).

TABLEAU II. TITRAGE DU POUVOIR HEMAGGLUTINANT.

Isolats	1	2	3	4	5	6	7	8	9	10	11	12
	-	-	-	-	-	-	-	-	-	-	-	-
C1	-	-	-	-	-	-	-	-	-	-	-	-
	+	+	+	+	+	+	-	-	-	-	-	-
C2	+	+	+	+	+	+	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
C3	-	-	-	-	-	-	-	-	-	-	-	-
LT1	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
LC1	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
	+	+	+	+	+	+	+	+	+	-	-	-
Pe	+	+	+	+	+	+	+	+	+	-	-	-
Dilution	2	4	8	16	32	64	128	256	512	1024	2048	TGR*

* TGR : témoin globules rouges ou hématies

Ainsi, C2 a un titre hémagglutinant égal à 64 UHA (Unité Hémagglutinante) ; alors que celui du témoin positif s'élève à 512 UHA. Les autres isolements ont été négatifs.

Par contre, LC1 n'a donné aucun titre hémagglutinant bien que ce prélèvement a provoqué une lyse cellulaire. Etait-ce une lyse non spécifique ou s'agit-il d'un virus non hémagglutinant?

Test d'Inhibition de l'Hémagglutination (IHA)

Le sérum de référence a respectivement les titres de (Tableau III):

- 512 (7log_2) en présence de C2 (4 UHA)
- 256 (6log_2) en présence de Pe (4 UHA)

Ce résultat nous permet de confirmer que l'isolat C2 est un virus de la maladie de Newcastle.

TABLEAU III. IDENTIFICATION DE L'ISOLAT C2 PAR TEST IHA.

Isolats	1	2	3	4	5	6	7	8	9	10	11	12
	-	-	-	-	-	-	-	+	+	+	-	-
C2	-	-	-	-	-	-	-	+	+	+	-	-
	-	-	-	-	-	-	+	+	+	+	-	-
Pe	-	-	-	-	-	-	+	+	+	+	-	-
Dilution SP*	8	16	32	64	128	256	512	1024	2048	4096	TS**	TGR

* SP : sérum positif de référence (AHS)
** : TS : témoin sérum

Agglutination rapide sur lame pour recherche de Salmonella

Quelque 113 sérums ont été testés avec l'antigène pullorique. Les résultats ont donné 2 positifs, 1 douteux et 110 négatifs (Tableau IV).

TABLEAU IV. RESLTATS DES TESTS A L'ANTIGENE PULLORIQUE.

	Dates de prélèvement						
Période	Juin 99	Février 00	Juin 00	Mai 01	Août 03	Sept./Nov.03	Déc.03
Nombre de sérums	6	9	3	12	7	57	19
Positif	0	0	0	**2**	0	0	0
Douteux	0	0	0	0	0	**1**	0
Négatif	6	9	3	10	5	56	19

Recherche d'anticorps anti-bursite (anti-IBD) et anti-bronchite infectieuses (anti-IBV)

Les dosages d'anticorps effectués sur les 50 sérums testés ont donné (Tableaux V et VI):

- pour la bursite infectieuse : 64% de positifs
- pour la bronchite infectieuse : 96% de positifs

De telles séroprévalences sont largement en faveur de la circulation des virus des deux maladies dans l'aviculture villageoise des deux zones écologiques étudiées.

TABLEAU V. RESULTATS D'ELISA INDIRECT POUR DETECTION D'ANTICORPS ANTI-IBD.

Statut	Négatif	Douteux	Positif	Total
Nombre	13	5	32	50
Pourcentage	26%	10%	64%	100

TABLEAU VI. RESULTATS D'ELISA INDIRECT POUR DETECTION D'ANTICORPS ANTI-IBV.

Statut	Négatif	Douteux	Positif	Total
Nombre	2	0	48	50
Pourcentage	4%	0%	96%	100

DISCUSSION

Le sous-secteur avicole traditionnel, basé sur l'élevage des volailles en liberté est très important dans le monde et en particulier en Afrique où il renferme plus de 80% de la population aviaire totale [5], et cela, malgré le taux de mortalité très élevé dû à la présence de multiples contraintes. Les maladies Fig.nt parmi les premiers facteurs limitant la productivité de l'aviculture traditionnelle. Les résultats rapportés par Permin et ses collaborateurs ont confirmé la diversité des maladies dans le sous-secteur [5]. Pour le cas de Madagascar, l'utilisation des vaccins contre toute une liste de pathologies aviaires, dans les élevages commerciaux, constitue déjà un premier indice en faveur de leur présence et leur importance économique [3].

Les données récoltées lors des enquêtes socio-économico-épidémiologiques, dans le cadre de ce projet ont confirmé l'importance de la MN sur la mortalité chez toutes les classes d'âge et des parasitoses internes spécialement sur celle des poussins [1, 2, 6, 7]. Cette classification de la MN comme maladie la plus dévastatrice de l'aviculture villageoise concorde parfaitement avec les résultats de recherche menés dans plusieurs autres pays africains [8, 9, 10, 11, 12]. La vaccination anti-Newcastle et le déparasitage des poussins sous mère, réalisés pendant notre première phase d'intervention ont considérablement réduit le taux global de mortalité de tout le cheptel encadré [1]. Quant aux autres maladies infectieuses, les méthodes de suivi et d'évaluation adoptées ne nous permettaient pas de mesurer leur présence ni leurs impacts dans le sous-secteur aviculture traditionnelle. Les travaux de Rajaonarison sont sans équivoque, en ce qui concerne la présence de la bursite infectieuse [2]. Les enquêtes séro-épidémiologiques de Porphyre ont confirmé cette présence et en plus, celle d'autres pathologies d'origine virale à savoir, la bronchite infectieuse (IBV), l'encephalomyélite aviaire, etc… avec des séro-prévalences respectives de 79,5% et 41,2% [3].

Un rapprochement sur la mortalité résiduelle des poussins vaccinés contre la MN a été tenté sur la base de ces résultats de Porphyre mais, les observations cliniques et les autopsies réalisées jusqu'alors ne permettaient pas de les confirmer. Seuls les syndromes respiratoires rencontrés ces deux dernières années, bien visibles chez la classe « adulte » (car ils s'accompagnent d'un arrêt de ponte chez la poule pondeuse), contemporains à une élévation de mortalité chez les poussins pourraient être éventuellement attribués à la bronchite infectieuse. Par contre, les enquêtes sérologiques étaient plus formelles : les dosages d'anticorps anti-IBV et anti-IBD en se servant du kit ELISA « CIVTEST » ont donné des résultats en parfaite concordance à ceux de Porphyre, en utilisant du kit « KPL » : avec un taux de séropositivité respectivement de 96% et 64%, indiquant la contamination et la circulation de ces virus dans l'aviculture villageoise des deux zones d'étude, comme dans beaucoup d'autres pays africains [3, 13]. Quant à la recherche d'anticorps anti-*Salmonella pullorum*, 2 sérums s'averraient être positifs sur les 113 sérums, récoltés à différents moments ; ce qui représente environ 1,77%. Bien que ce taux soit relativement bas par rapport à ceux d'autres pays, ce résultat constitue un indice en faveur de la présence du germe *Salmonella pullorum* [13]. La salmonellose à *S. pullorum*, intéresse beaucoup plus les poussins, alors que les sérums testés provenaient des classes « poulette » et « adulte ». L'utilisation de l'antigène *S. gallinarum* serait beaucoup plus adéquate pour tester ces sérums.

Ces quelques résultats confirmaient, une fois de plus, la diversité des maladies évoluant dans le système où l'on peut dire qu'un oiseau mourant lors du passage de la MN par exemple, pouvait à la fois être polyparasité, séropositif contre plusieurs autres maladies et souffrant en même temps d'une carence nutritionnelle chronique [13].

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THE SOCIO-ECONOMIC IMPORTANCE OF FAMILY POULTRY PRODUCTION IN THE REPUBLIC OF MAURITIUS

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Abstract

Almost every household keeps semi-scavenging family poultry in the backyard as a tradition, both for food and for the generation of additional income in Rodrigues, the second biggest island of the Republic of Mauritius. Recent studies have shown that improving husbandry and management practices on the farm can increase the return of the family poultry farmer significantly. A survey was carried out on households with family poultry on the social and economic importance of family poultry production on the island in 2002. Results showed that on an average, the family poultry farmer was 50 years of age, 42% were illiterate, 32% of the farmers were women, and the family consisted of five members. Besides their main occupation, animal farming was the main side-activity of 56% of the households. 50% of the respondents reared chickens firstly for income, 43% for home consumption, 4% for cultural reasons, and 3% simply for leisure. The profit obtained from the sale of chickens and eggs, and the monetary value of sale and home consumption of these commodities represented 9% and 18% of the total income of the family, respectively. 65% of the households wished to expand family poultry production as they found this system of production more profitable than the rearing improved commercial broilers and layers. The birds of 5% of the farmers constituted a nuisance to their neighbours. All the poultry merchants who marketed the family poultry found their business profitable, and wished to expand it. They priced the birds by their appearance, offered US $ 2 / kg live weight, and sold them at US $ 3.4 / kg live-weight to consumers in Mauritius. Family poultry had a guaranteed market, especially for being free scavenging birds, and for their rustic taste.

Key words: Family poultry, survey, socio-economics, marketing, Mauritius

INTRODUCTION

Rodrigues is the second biggest island of the Republic of Mauritius, 110 km² in area and is situated 595 km away from Mauritius, the main island of the Republic. Agriculture, livestock farming and fishing are the main occupation of the majority of the 35000 inhabitants of the island. This island has not developed socially and economically as compared to Mauritius, which, with an area of 1860 km², and a population of 1.2 million, is getting industrialized, and has a Gross Domestic Product of US $ 4215. The economic sectors are namely, the services sector, the manufacturing sector, and agriculture that contribute to 70%, 24% and 6% respectively to the national economy. Livestock and poultry contribute to 12% in the share of agriculture. The Republic of Mauritius is self-sufficient in poultry meat and eggs, the bulk of which is produced by industrial farms. The present yearly poultry meat production is estimated at 30000 tons. Family poultry production is not of economic importance to Mauritius, but in Rodrigues, the rearing of the semi-scavenging and so-called 'local' breed of chickens is considered to be an important source of both food and income to a large number of Rodriguan families. An improvement in this system of poultry production was initiated through the joint FAO / IAEA applied research programme in which a survey was first carried out in three regions of the island, namely Citronelle, St Gabriel and Trefles. The survey involving 15 farmers having 'local' chickens was carried out in the winter season of 1999 and was repeated in the summer season of 2000. It provided base-line data on flock size and structure, husbandry practices and the main problems encountered by the farmers [1].

Based on the findings of the survey, interventions namely, vaccination against Newcastle disease and Fowl pox, control of parasitic infestations and improvement in the housing of the semi-scavenging chickens, were made on the same farms that were surveyed, for the purpose of improving poultry productivity. The interventions were made from June 2001 to February 2002, and were repeated from October 2002 to March 2003, and on the reproductive performance, feeding practices and feed costs, diseases, mortality, disposal of farm produce, and the benefits that the farmers derived from this activity, were investigated.

As the interventions and investigations were limited to a small group of family poultry farmers, additional information was required to make an assessment of the social and economic importance of this system of poultry production in Rodrigues. This survey was carried out on a larger group of households, and from the whole island, in the months of November and December 2002, and also included the poultry merchants who market the live chickens in Mauritius. The survey enabled to make an appraisal of the social and economic importance of the semi-scavenging chickens to Rodriguans, and the needs of both farmers and poultry merchants for improving further this side-activity.

MATERIALS AND METHODS

The survey consisted of two parts namely, a socio-economic survey and a market survey, and was conducted in the months of November and December 2002. 100 households who were rearing domestic chickens were randomly selected from the whole island. The family poultry dealers who are around five in number, and who are commonly known as "poultry merchants", were also involved in the survey.

Socio-economic survey

A standard questionnaire was used, and each of those persons in the household who was responsible for the farming activity was interviewed at his residence for recording information. The information collected pertained to the following:

- profile of farmer
- management of the farm
- production costs and revenue
- problems and constraints
- support services
- environmental issues
- prospects

Market survey:

Another standard questionnaire was used to interview the family poultry dealers. Four of the five merchants were interviewed in the month of December 2002 at their residence. The following information was collected from them:

- profile of the poultry dealer
- method of purchase

- price determination
- handling of chickens prior to export
- export procedures
- selling of chickens
- problems, constraints and prospects in the marketing system.

RESULTS

Socio-economic survey

Profile of farmer

Sex

68% of the respondents were males and 32% were females.

Age

The age of the respondents ranged between 14 and 81 years, with most of them being around 50 years.

Marital status

63% respondents were married and 17 were single, of whom 6 were unmarried children of the family aged between 14 and 36 years.

Status in the household

68% of the respondents were heads of households and 26% were spouses, as shown below, in Table I.

TABLE I. STATUS OF RESPONDENTS IN THE HOUSEHOLD.

Status in household	Number of persons (%)
Head	68
Spouses (females)	26
Unmarried male children	6
Total	100

Out of the 68% of head of households, 11% were females.

Number of members in the family

The number of members in the family was in the range of 1 and 10 and was 4.5 on average.

Occupation

The respondents had varied types of occupation, with no special categories, and included government employees, farmers, labourers, and self-employed artisans. However, 23 were housewives, 16 were planters and 14 were labourers.

Educational Status

42% of the respondents had never attended school. 44% had education up to primary level, and 14% had attended secondary school.

Income

The approximate monthly income of the respondent was in the range of Mauritian rupees (MUR) 200 and MUR 8,200, and that of the whole family was in the range of MUR 1,500 and MUR 14,000. Over 50% of both respondents and families earned between MUR 4,000 and MUR 8,000, as shown in Table II (1 US $ = 29 Mauritian rupees).

TABLE II. MONTHLY INCOME OF THE RESPONDENTS AND THEIR FAMILIES.

Revenue (Rupees) Range	Number of respondents (%)	Number of families (%)
200–2000	23	9
2001–4000	18	16
4001–8000	59	57
8000–14000	-	17

The income of the respondent was calculated to be on an average R 4112 per month, and the total income of the family including that of the respondent was R 5773 per month.

Activities

Apart from a full time job, animal farming was the main activity of 56% of the respondents, while crop farming and fishing were the main activity of 37% and 7% respondents, respectively, as shown in Table III.

TABLE III. ACTIVITIES OF RESPONDENTS.

	Main activity Number of respondents (%)	Second activity Number of respondents (%)	Third activity Number of respondents (%)
Animal farming	56	27	4
Crop farming	37	28	0
Fishing	7	2	2
Tailoring	0	1	0

Livestock farming activities

Besides keeping family poultry, the respondents reared cattle, sheep, goats and pigs, and in varying numbers, as given in Table IV.

23% reared 18 head of sheep

The estimated revenue of the previous year obtained from each of these animals was on an average MUR 8,379, MUR 13,278, MUR 3680 and MUR 8,485 per farmer, respectively, as shown in Table IV. The average yearly revenue from livestock was calculated to be MUR 15333 per household. This represented 31% and 22% of the income of the farmer and of the family, respectively (Table IV).

TABLE IV. LIVESTOCK OWNED AND REVENUE OBTAINED.

		Number of animals		Revenue obtained (2002)		
Species owned	% farmers	Range	Average	% farmers	Range (rupees)	Average (rupees)
Cattle	54	1–25	4.6	15	2000–80, 000	13,278
Sheep	23	1–90	18	7	2000–15, 000	8, 485
Goats	33	1–70	6.1	5	2000–8000	3, 680
Pigs	59	1–13	3.2	52	1200–26, 000	8,379

Experience in family poultry production

The farmers were keeping family chickens for one to 60 years. Their experience the rearing of domestic chickens was as follows:

Number of years of experience	% farmers
1-5	21
6-10	17
11-20	15
21-30	18
31-40	18
41-60	11
Total	100

It is to be noted that a fair share (21%) of the farmers had relatively fewer number of years of experience (1 to 5 years).

Reasons for keeping domestic chickens

As a first priority, 50% of the respondents were keeping domestic chickens for generating income, while 43% reared them for their own consumption. Another 7% were keeping these either for cultural reasons or simply for leisure, as shown in Table V.

TABLE V. REASONS FOR KEEPING FAMILY CHICKENS.

Reasons	Priority 1 (% respondents)	Priority 2 (% respondents)	Priority 3 (% respondents)
Source of income	50	35	4
Own consumption	43	50	3
Cultural	4	1	13
Leisure	3	1	2

Managing family poultry

Sources of local chickens

99% of the respondents maintained their flock of local chickens out of their own farm, while 1% purchased chickens from other farms when the need arose.

Flock size and structure

The number of local chickens on the farms was in the range of 5 and 204 and was 39.2 on an average. The largest number of farms (70%) had between 10 and 50 local chickens, as shown below:

No. of local chickens	Number of farms
< 10	3
11-50	70
51-100	20
101-150	5
>151	2
Total	100

Besides rearing local chickens the farmers also kept other species of fowl, as shown in Table VI.

TABLE VI. FLOCK SIZE AND STRUCTURE.

Type of fowl	% farms	Number of birds	Range	Average number of birds per farm
Local chickens	100	3922	5–204	39.2
Broilers	37	419	2–35	12.6
Layers	4	219	2–200	54.7
Ducks	4	41	3–16	10.2
Turkeys	2	12	1–11	6

Housing

50% of the respondents had a shelter for their chickens. The size of shelter ranged between 2 and 32 m^2 and was on an average 7.3 m^2. The chickens were housed permanently on 16% of the farms, while only night shelter was provided on 33% of the farms, and 3% of the farms provided shelter for brooding only. Thus, the chickens were kept in a free range scavenging system on the majority of farms. The farmers who had a shelter for their chickens had spent between MUR 100 and MUR 12, 000 and MUR 1112 on an average on the construction of the shelter, as shown in Table VII.

TABLE VII. EXPENSES FROM THE CONSTRUCTION OF A SHELTER FOR THE CHICKENS.

Number of birds	Range of housing cost (MUR)	Number of farms
< 10	450	1
11-50	200-6000	32
51-100	100-12000	12
101-200	200-700	4
>201	600	1

Feeding

97 % of the respondents allowed their chickens including the chicks to roam around the house for scavenging. All of them gave supplementary feeds to the birds, and in different combinations. The supplements consisted of rice, concentrate, maize, sweet potato, and bread which were given on 84%, 62%, 44%, 6% and 1% of the farms, respectively. The frequency

at which these supplements were fed varied from farm to farm. Feed costs also varied according to the number of birds, and the type and frequency at which these supplements were given. The expenses that incurred on feeding by the householders was in the range of MUR 76 and MUR 3,188, and was MUR 548 per household per month, on an average. The feeding practices and costs of feeding are given in Tables VIII and IX respectively.

TABLE VIII. FEEDING OF SUPPLEMENTS TO THE CHICKENS.

	Frequency of feeding		
	Daily (% farms)	Occasionally (% farms)	Seasonally (% farms)
Concentrate	42	19	1
Rice	80	1	3
Bread	1	0	0
Maize	16	9	20
Sweet potato	0	0	6

TABLE IX. COST OF FEEDING OF SUPPLEMENTS.

	Quantity fed (kg/mth)		Cost (Rupees/month)	
	Range	Average	Range	Average
Concentrate	2.5–225	43.7	23–2138	372
Rice	5–150	12	25–855	180
Bread	-	12	-	120
Maize	75–500	56.6	38–2500	331
Sweet potato	-	66	-	174

Disease occurrence and measures taken to control disease on the farms

76% of the farmers had experienced disease problems on their farms during the current year. 59% of the farmers had experienced the problems in the dry season (July–December). Infections diseases were the major disease problems encountered on the majority of farms. These infectious diseases were described on the basis of the signs of disease that the farmers had observed, as given in Table X. The farmers resorted both to veterinary drugs, which they obtained free from the veterinary services, and traditional methods, for the treatment and control of those diseases in their flocks of birds. The treatments varied from antibiotics to kitchen oil, lemon juice, etc. as shown in Table X.

TABLE X. DISEASE PROBLEMS AND TREATMENT GIVEN.

Disease problem	Importance of the disease problem				Treatment given
	1* % farms	2 % farms	3 % farms	4 % farms	
Twisted neck	27	14	4	1	Antibiotics
Paralysed legs/ drooping wings	31	11	9	2	Antibiotics
Respiratory diseases	68	29	13	9	Antibiotics
Diarrhoea	31	7	6	9	Antibiotics, kitchen oil, lemon juice.
Fowl pox	44	4	13	13	Iodine, tomato, kitchen oil,'herbe martin', shoe polish
Lice/mites	5	1	2	0	Tabac marron

* 1 to 4: Decreasing order of importance (1= highest; 4 = lowest)

Losses of birds

The farmers suffered loss of birds due to disease, predation or were simply losing them in the open. Deaths due to disease occurred on 59% of farms. Disease was the main cause of their loss, and the deaths were more or less the same magnitude in adults, growers and chicks. Predation and getting lost while erring occurred mostly in chicks on 22% and 10% of farms respectively. The losses due to these various causes are given in Table XI.

TABLE XI. LOSSES OF BIRDS IN 2002.

Cause of loss	Adults		Growers		Chicks	
	% farms	Average N /farm	% farms	Average N/farm	% farms	Average N/farm
Disease	59	28.6	56	27.8	56	34.7
Predation	2	15	4	17.7	22	14.6
Lost	1	15	5	17.4	10	44.6

The losses of birds due to disease in adults, growers, and chicks were calculated to be 17.3%, 17.1% and 27.1% per farm, per year, respectively.

Vaccination

The majority of farmers did not vaccinate their chickens against the three most common and universally occurring diseases of economic importance as shown below.

Disease	Birds vaccinated (% farms)
Newcastle disease	22%
Fowl pox	17%
Infectious bursal disease	1%

Support Services

The support that the farmers received were namely, from the Veterinary Services, Extension service, and cooperatives, and were as follows:

- 65% of the farmers had obtained veterinary aid
- 31% had received advice from Extension Service
- 75% were aware of the existence of cooperative societies
- 18% farmers were members of a cooperative society
- 84% expressed the need for a cooperative society

The need for a cooperative society was expressed as follows:

Need	% farmers
Increase knowledge of farming	81
Availability of drugs	8
Marketing facilities	4
Availability of feeds	6
Availability of chicks	2

Disposal of chickens and eggs and income derived

52% of the farmers indicated selling their farm produce, 46% were unable to sell, and 2% were not selling. Chickens and eggs were both consumed and sold on 72% of the farms. The disposal of chickens and eggs during the previous month is given in Table XII.

TABLE XII. DISPOSAL OF CHICKENS AND EGGS AND INCOME DERIVED.

	Chickens			Eggs		
	% farms	Ave. no./ mth /farm	Value[1] Rupees/ mth /farm	% farms	Ave. no./ mth /farm	Value[2] Rupees/mth/farm
Donations	-	-	-	5	16	44
Own consumption	63	4.0	542	73	22	54
Sold in the same village	32	8.0	1,077	9	111	278
Sold to merchants	30	6.0	717	-	-	-

1. Market value of 1 adult live chicken assumed at MUR 130
2. Market value of 1 egg assumed at MUR 2.50

Revenue from family poultry

The monthly monetary value representing sale, donations and home consumption of chickens and eggs was in the range of MUR 25 and MUR 8,101, and MUR 1,500 (US $ 52) on an average, per farm, whereas the revenue obtained from the sale of chickens and eggs was on average MUR 1,012 (US $ 35) per farm per month. The profit of that the farmer obtained through the sale of chickens and eggs, by subtracting the feed costs from the revenue, was on an average MUR 464 per month (US $ 16). This profit represented 8.9 % of the monthly income of the farmer, and 12 % of that of the family.

Environmental issues

- 61% of the farmers did not dispose of chicken manure,
- 38% utilized it for crop production,
- 1% utilized it for making of compost,
- 5% of farmers received complaints from neighbours because the birds caused nuisance to plantations.

Fencing

10% of farmers had a fence around their house which limited the movements of the chickens.

Warning from environment enforcement authorities

No farmer had received any warning from the police, sanitary or any other officer, regarding chicken rearing.

Prospects in poultry farming

66% of the farmers wished to expand their poultry farming activity. Out of these, 65% preferred to expand the farming of the 'local' chickens, 8% would go for broilers and 4% for layers. 44% of those who preferred to expand local chicken production believed that local chickens were more profitable than other types while 36% believed that they were easier to manage, as shown in Table XIII.

TABLE XIII. REASONS FOR EXPANDING POULTRY FARMING ACTIVITY.

		Reasons (% farmers)				
Type of chicken	% farms	Market guaranteed	More profitable	For own consumption	Resistant to disease	Easily managed
Local	65	12	44	-	1	36
Broilers	8	-	40	60	-	-
Layers	4	-	100	-	-	-
No preference	23	-	-	-	-	-

23% of the farmers had no preference for any specific type of chickens.

Major constraints limiting family poultry farming activity

Disease was reported to be the major constraint of 58% of the farmers while inadequate veterinary and extension service, and high feed costs were constraints met by 17% and 13% of the farmers, respectively. Other minor constraints were lack of finance, inadequate housing, inadequate support from family members, lack of water, predation and inadequate fencing/shelter, amongst the remaining 12% of the farmers.

Suggestions for improving family chicken production

Farmers made suggestions in order to improve family poultry production. These suggestions were as follows:

Suggestions	% farmers
Family poultry production must be promoted	78
Veterinary service must be improved	45
Extension service must be improved	33
Introduce similar improved breeds	8
Govt. subsidy in terms of leased land, fencing and feeds	34

Type of chicken and egg preferred for consumption

Egg: 93% respondents preferred to consume local eggs
4% preferred eggs from commercial layers
3% had no preference
Chicken: 87% preferred to consume local chickens
9% preferred broilers
4% had no preference

The majority of farmers associated their preference of the local chicken and egg to taste, as shown in Table XIV.

TABLE XIV. REASONS FOR PREFERRING LOCAL EGGS AND CHICKENS.

Item	Reasons Taste (% farmers)	Nutritive value (% farmers)	Obtained free of costs (% farmers)
Eggs	76	20	4
Chickens	87	13	-

Market survey

Marketing activity

The marketing of family poultry was effected by specific individuals in the business, and were referred to as chicken traders or chicken merchants. It was a part-time activity of all the four respondents, their main activity being shop-keeping (75%) and restaurant keeping (25%). They were involved in marketing only family poultry. Their individual involvement in this activity ranged between 5 to 60 years.

Purchase of local chickens

Three out of the four chicken traders purchased local chickens throughout the year, while one purchased at specific times when the order existed, and the purchases were timed with the schedule of the trips of the ship.

All the chicken traders had only a verbal agreement with the farmers for the supply and purchase of chickens. The chicken traders went directly to 75% of the farmers for purchase, while 25% farmers brought their chickens to the middlemen.

Three chicken traders had regular suppliers (farmers). 60% of the purchase was from the regular farmers.

Frequency of purchase

Three chicken traders purchased chickens 1-2 times per month. One farmer purchased 4 times per month. The latter would buy young growers and keep them until ready for sale.

Number of birds purchased

The number of birds purchased per month by the chicken traders was in the range of 180 to 600 and was on average 360 birds/month.

Price determination

The price of the chicken was determined on live-weight and not on appearance (colour) or sex, and the birds were weighed at purchase. The average weight of a live chicken was around 1.75 kg. The price ranged between Rs 60-80/kg live-weight and was on an average Rs.70/kg. The variation in the buying price occurred all year round. The price fluctuated more during festive occasions, such as end of year and Chinese New Year celebrations, when the selling price was highest. The price was mutually determined by both buyer and seller, but was usually by the merchant.

Criteria used for purchasing chickens

All the chicken traders used weight as the first criterion, then age and appearance as the second criterion. They usually purchased all the birds and did not select only the best ones. The reason being that the quality of the chickens was always the same.

Handling of the chickens during purchase and handling costs

The birds were transported in lorries or vans from villages at farm gate or at meeting points near the village. The birds were placed in crates made of wire netting. The costs incurred by the chicken trader for transportation was between Rs 300-500 per month.

Selling of chickens

Three of the four chicken traders were also retailers, and sold the chickens themselves. One had a relative as counterpart for retailing. The chickens were sold directly to consumers. They were exported live to Mauritius by ship. A negligible number of chickens was sold live to consumers in Rodrigues.

Export of chickens live to Mauritius

Three of the four chicken traders exported the chickens at a frequency of 1-2 times per month. One of them exported once every two months. 200-900 chickens were exported by chicken traders each month, and which represented 475 birds or 7 baskets on an average, per chicken trader per month. The birds were transported in the ship in baskets with around 60 birds per basket. (Official Figures indicate that around 26,100 chickens were exported on an average per year during the past 10 years, and showed a more or less constant trend) [2]. The ship takes around 36 hours to reach Mauritius. Prior to export, the chickens were kept during 2 to 3 days in cages, at the premises of the chicken traders, the majority of whom reside at the small sea port town of Port Mathurin, and in the vicinity of the port. Recently, the authorities have urged the traders to keep their chickens at a specific place adjoining the port, being given that their neighbours had complained of foul odour.

Losses

2%-5% of death losses occurred prior to export. In addition, 1%-2% losses occurred during transportation by ship, and this was due to deaths and thefts. Baskets that were loaded last were more prone to thefts.

Costs incurred for export by the chicken traders

- In Rodrigues:
- Labour and feeds prior to shipping: MUR 300-500
- Permit: MUR 50
- Water on board for birds: MUR 15-20
- Freight charges per basket: MUR 420
- The export of one monthly consignment of 475 birds (7 baskets) thus cost to the trader around MUR 3,500.

In Mauritius:

Three of the four chicken traders transported the chickens straight to the sale point in the Royal Street area of Port Louis, which is in the heart of the city, and is commonly known as ‘China Town’, while one took them to a holding place in Roche Bois first, and then to that selling place.

Transportation of the chickens was effected in lorries. Around MUR 300 were spent on transport and MUR 600-1500 were spent on labour.

Point of sale

Most of the birds were sold at Royal Street, City of Port Louis which is the capital of Mauritius, and the sale was usually over on the very day of their arrival.

Selling price

The selling price ranged between Rs 90-100/kg live-weight, reaching the peak during festive occasions like end of year and Chinese New Year. Young birds especially cocks, fetched a higher price.

Profitability

This activity was profitable to all the chicken traders. They wished to expand the activity, as there was a promising market.

Customers

People from the Chinese community were the main consumers, with very few consumers from other communities.

Problems and constraints faced by the chicken traders

The chicken traders considered that:

- Keeping the chickens at the Quay premises in Rodrigues one day before loading was not necessary, as they were residing quite near to the sea port.
- Occasional thefts during transport by ship resulted in loss in revenue, and no compensation was given by the shipping company for such losses, as there was no system of insurance in place.
- Freight charges were considered to be high.
- There was no appropriate market place for the selling of the chickens in Mauritius.
- They did not have any permit for selling the chickens.

They were harassed by municipal sanitary officers, and police officers, as they were allowed to sell the chickens for only one day.

CONCLUSION

- Family poultry production in Rodrigues, that is the rearing the so-called 'local' Rodriguan breed of chickens, was a side-activity that was carried out mainly by elderly male heads of household, spouses and housewives, whose families had around four members.

- Excepting housewives, the heads of household and spouses who reared family poultry had as a main occupation (i) farming (ii) self-employed artisan (iii) labourer (iv) government employee (in decreasing order of numbers). Besides their main occupation, the family poultry farmers were also engaged in other activities namely, (i) livestock farming (ii) crop farming, and (iii) fishing (in decreasing order of importance).

- The poultry farmers were mostly uneducated or had some education at primary level, belonged to the low-income group, and had a few to many years of experience of family poultry keeping.

- The farmers reared from a few to hundreds of the 'local' chickens, and they reared them firstly for the generation of additional income, and secondly for home consumption. A few persons also kept these chickens for cultural reasons or simply for leisure.

- Besides rearing the 'local' chickens, more than one-third of the family poultry farmers also reared broiler chickens, mostly for their own consumption. A few of them had layers, ducks and turkeys. The rearing of broilers was an indication that they liked to have more fleshy fowl and more rapidly.

- Besides having poultry, a large number of the farmers reared pigs, cattle, goats and sheep (in decreasing order of importance), for a source of income.

- Although 52% of the households had an artisanal chicken house, chickens were permanently housed on only 16% of the farms. This resulted in a significant loss of birds due to environmental factors. Improving the housing of the chickens, especially for chicks, could reduce the loss.

- Birds were allowed to scavenge in the open for feeding themselves on nearly all the farms (97% farms), but a large proportion of the farmers also gave supplementary feeds which were mainly rice (on 84% of the farms) and concentrate (on 62% of the farms), which were purchased. The concentrate feeds are meant for high-producing fowl like broilers and layers. Therefore, if the farmers were sensitized to make a judicious use of those concentrates, their returns would have increased.

- Diseases, especially of infectious origin, occurred on a majority of farms, and were the main causes of deaths and thus, economic loss. Since only 22% and 17% of the farmers were vaccinating their flocks against Newcastle disease and Fowl pox, respectively, efforts ought to be engaged in having all the family chickens vaccinated against these diseases.

- The majority of farmers expressed the need for a cooperative society and increased support, for improving their know-how on poultry farming. Extension thrust could, therefore, help in improving their farming activity.

- Chickens and eggs produced were consumed and sold on the majority of farms, and the farmer was making a profit which represented around 12 % of the income of the family. This indicated that family poultry production was of economic importance to them. This furthermore explains why a majority of farmers wished to expand the activity of rearing ‘local’ chickens.

- The majority of farmers believed that the rearing of the ‘local’ chickens was more profitable and easier to manage than broilers or layers (commercial improved breeds), but land, fencing and feed cost was high.. This activity could therefore, be promoted if adequate support could be given to them in terms of lease of land, subsidies on feeds and on fencing materials.

- The majority of farmers preferred the ‘local’ chicken and egg for consumption, especially for their taste. This was an indication of the social importance of these chickens.

- The major constraints that limited family poultry farming activity were namely, poultry diseases, inadequate veterinary and extension service and high feed costs. These could be overcome by vaccination and other disease control measures, and support from Government. Housing of young birds, improvement of chicken houses and fencing would also help in reducing losses due to deaths and predation, and make family poultry production more environment friendly.

- Family poultry has a promising market especially within the Sino-Mauritian community in Mauritius. There is a need for educating farmers to improve the quality of their ‘local’ chickens so as to satisfy consumer demand. Provision of a suitable market place in the vicinity of ‘China Town’ would enable easier sale of the chickens.

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IMPROVING FARMYARD POULTRY PRODUCTION ON SMALLHOLDER FARMS IN MAURITIUS

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Abstract

A rapid expansion of the industrial production of broilers and eggs during the past decades has reduced family poultry production to an insignificant side-activity in Mauritius, the main island of the Republic of Mauritius. In contrast, the latter system of production continues to be an important farming activity both for the generation of additional income and for home consumption, for most of the inhabitants of Rodrigues, the second biggest island of the Republic. A recent survey that was undertaken on selected farms on both islands enabled the identification of the problems that the family poultry farmers were facing, and the prospects in that area. Interventions were made accordingly to address the main problems for improving farmyard production, on the same households, and on both islands. The interventions were made in two phases between June 2001 and March 2003, and consisted of providing a low-cost housing for the birds, vaccination of the flocks against Newcastle disease and Fowl pox, and the control of parasitic infestations. Farm productivity was monitored during the intervention period and the effectiveness of the interventions was assessed. Results showed that the farmer obtained an additional return of 4.2 in Mauritius and 6.0 in Rodrigues, on a yearly basis, for every additional dollar that was invested on vaccinations and endoparasitic control. Housing of chicks brought an additional return of 0.6 per farm. Survivability rate of chicks till the age of six weeks was 50% in Mauritius and 52% in Rodrigues, respectively. A mortality rate of around 43% was recorded on vaccinated as well as on unvaccinated flocks against Newcastle disease, and on both islands, although no clinical case of the disease was reported during the interventions. Parasitic infestations due to helminthes, coccidia, lice and mites were effectively controlled after a single prophylactic treatment with commonly used drugs.

Key words: Family poultry, semi-scavenging, interventions, improvement, Mauritius.

INTRODUCTION

The production trend of poultry meat and eggs has been increasing in the Republic of Mauritius during the last decades, with an increase in the number of industrial farms, thereby maintaining self-sufficiency for these commodities in the country. The poultry industry presently produces around 30000 tons of broiler meat in order to meet the demand of the 1.2 million inhabitants and of around 700,000 tourists who visit the island every year. This flourishing poultry industry has caused the rearing of semi-scavenging family poultry to become an insignificant side-activity in Mauritius, the main island of the Republic, in contrast to Rodrigues, the second bigger one, with a population of 35,000, and situated 595 km. away, where agricultural farming and artisanal fishing are the main activities of the inhabitants.

The major problems that the family poultry farmers have been facing were highlighted in the results of a survey that was carried out in 1999 and repeated in 2000 [1]. These were described as competition from the industrial farms in Mauritius, while inadequate veterinary and extension support, and poor housing and management, were the main ones on the island of Rodrigues.

Based on these results, interventions were made on the same households that were surveyed in both Mauritius (Zone I) and Rodrigues (Zone II), with a holistic approach for improving family poultry productivity. The interventions comprised a vaccination programme against Newcastle disease and Fowl pox, introduction of a low-cost chicken house and improvement of the existing ones, and the control of parasitic infestations through medication. The interventions were undertaken in two phases, from June 2001 to March 2002 (Phase 1) in both zones, and were repeated from October 2002 to March 2003 (Phase 2) in Zone II, Rodrigues. During the interventions farm productivity was monitored for obtaining data on the flock size and structure, feed cost, reproduction, mortality, and sale and consumption of chickens and eggs. The revenue derived and the profit and return that the farmer obtained from the sale of adult birds was calculated. Faecal examination was undertaken for the identification of helminthe parasites and to assess the effect of the anthelmintics and anticoccidians on endo-parasitic infections. Blood was collected for the detection of haemoparasites, and for the conduction of serological tests to assess the effectiveness of the vaccination programme against Newcastle disease.

MATERIALS AND METHODS

Selection of farms

The same households with family poultry that were randomly selected and surveyed [1], were retained for the interventions. 12 households were involved in Mauritius (Zone I) and 15 in Rodrigues (Zone II), respectively. These were divided in a Treatment group and a Control group as shown in Table I.

TABLE I. SELECTION OF FARMS FOR MAKING INTERVENTIONS.

No. of farms	Zone I – Mauritius	Zone II – Rodrigues
Treatment	8	10
Control	4	5
Total	12	15

Interventions at farm level

The interventions on the farms consisted of the following:

- Introduction of a low-cost housing for the chickens.
- A vaccination programme against Newcastle disease and Fowl pox.
- Control of parasitic infections

Materials for the construction of a shelter for the chickens, vaccines, and drugs and were given free of charge to the farmers. The interventions were made simultaneously in both zones in a first phase - Phase 1 (June 2001 to May 2002), and were repeated in a second phase – Phase 2 (October 2002 to March 2003), only in Rodrigues, and on the same farms. All the three interventions were made on the Treatment group, whereas there was no vaccination against Newcastle disease in the Control group.

In Phase 2, three farms were dropped out, due to the unwillingness of the farmers to continue to participate in the project. In this phase, the farms were divided into a Treatment group of eight farms where chicks were housed day and night, and a Control group of four farms where no birds were housed at all, and all the birds were allowed to roam and scavenge in the yard.

Farmers were trained to vaccinate their birds themselves and to maintain records on record sheets that were given to them. A calendar of the on-going activities was kept on all the farms during the intervention periods, and the activities were monitored through weekly visits in Phase 1 and on monthly visits in Phase 2.

The interventions that were undertaken during the two phases are given in Table II.

TABLE II. INTERVENTIONS ON THE FARMS.

Phase 1 (June 2001 to May 2002)			Phase 2 (October 2002–March 2003)	
Zone I & II			Zone II only	
Interventions	Treatment	Control	Treatment	Control
Vaccination against ND	-Day 1[1] flock -All D.O.C[2] -Re-vac of flock every 3 months	Day 1[1] only	-Flock -All D.O.C -Re-vac of flock every 3 months	-Flock -All D.O.C -Re-vac of flock every 3 months
Vaccination against fowl pox[3]	Chicks at 21 days	Chicks at 21 days	Chicks at 21 days	Chicks at 21 days
Endoparasitic control	Once every 3 months	Once every 3 months	Once every 3 months	Once every 3 months
Improvement of housing[3]	Yes	Yes	Yes	Yes
Ectoparasitic control[3]	No	No	Yes	Yes
Chicks housed permanently	No	No	Yes	No

1: Start of vaccination programme, June 2001
2: Day old chicks
3: As from 1st September 2001

Interventions - Phase 1

The interventions and scientific investigations were as follows:

Vaccination against Newcastle disease

The flocks were vaccinated with locally available freeze-dried, thermostable NDV4 vaccine, presented in vials of 200 doses. The farmers were asked to store the vaccine at +2 to +8° C. The application of vaccine was demonstrated to the farmers. The programme of vaccination was as follows:

Treatment group

All Day old chicks: 1-2 drops by the intra-ocular route, by means of a dropper supplied, and after reconstitution of one vial in 10 ml of water.

Rest of flock: Day 1, that is, on 1st June 2001, via drinking water. The vaccine was reconstituted by diluting one vial with 1.5 litres of previously boiled and cooled water, or in commercial mineral water.

Re-vaccination of flock: 3 months after the first vaccination, that is on 01 September 2001, and then subsequently, at regular intervals of three months.

Control group

Flock: Day 1 only, via drinking water.

Vaccination against Fowl pox

All chicks on both Treatment and Control farms were vaccinated at 21 days of age as from 1st September 2001, intra-dermally, by the thigh prick method, with vaccine obtained from the Veterinary Services, in vials of 50 doses each. Farmers stored the vaccine at + 2 to + 8° C.

Control of endo-parasitic infestations

A prophylactic treatment was given to the flock for controlling helminthes and coccidian parasites on the farms, in both Treatment and Control groups, at regular intervals of three months, as follows:

Control of helminth parasites

Piperazine chlordydrate with 36% as piperazine base was administered once to the flock, at the rate of 1 g/ litre of drinking water. In the treatment group, the drug was administered 3 weeks before each vaccination of the flock against Newcastle disease. Treatment was repeated at regular intervals of three months and over a period of one year. On farms where flocks would be found to be highly infested, the treatment would be repeated at 3 weeks after the initial application.

Control of coccidian parasites

21.3% Sulphadimidine in combination with 2.6% Diaveridine was administered to the flock at the rate of 1 g / litre of drinking water. The treatment was given one week after administration of the anthelmintic, and following this schedule, it repeated at regular intervals of three months over a period of one year.

Collection and examination of faecal samples

2 to 3 fresh faecal samples of around 4 g each were collected from the ground on each farm before the administration of the anthelmintic, once every three months, for the detection of endo-parasitic helminthes eggs and coccidian oocysts. A total of 72 and 97 samples were thus collected from Zones I and II respectively, during the interventions. Where faecal analysis was not possible on the same day the samples were stored in the refrigerator at + 2 to + 8° C and was analysed on the following day. Qualitative examination of the samples was carried out using the Simple Flotation Technique as described by Benbrook et al., 1961 [2], Permin and Hansen, 1998 [3], and Troncy et al, 1981 [4].

Introduction of a low-cost housing for the chickens

A low-cost 10 ft x 10ft and 8 ft high chicken shelter was designed. The purpose of the shelter was to enable four hens to lay eggs and incubate them, and provide protection to the chicks in inclement weather, until six weeks of age. Construction materials were distributed free of charge to the farmers, and these were according to the characteristics of each zone, as follows:

- Zone I (Mauritius):20 wooden poles, 5 corrugated iron sheets and 50 feet of wire mesh.
- Zone II (Rodrigues):24 wooden poles, 20 'Latanier' leaves and 50 feet of wire mesh

The shelter was partly covered, had an open space, was on bare ground, and was constructed by the farmer himself in his farmyard.

Monitoring of farm productivity

All the households were visited at the end of each month, for the collection of production data, using data entry forms. Data was collected from the farmers for the first three months as from June 2001 before the start of the intervention programme. Further data was collected after the start of the intervention programme, for seven consecutive months in Zone I and for six consecutive months in Zone II, respectively, as from September 2001. Information was collected as follows:

- Number of cocks, hens, growers and chicks.
- Number of birds and eggs consumed or donated.
- Number of birds that died
- Types and quantity of feeds used and feed costs.
- Other expenses incurred and purpose.
- Revenue obtained from the sale of chickens and eggs.

Calculation of revenue (income), and partial budgeting

Before the intervention programme:

- *Treatment and Control farms:* The costs before the programme had started were the expenses that the farmer would incur (as all items were provided free) on a single vaccination against Newcastle disease and the labour cost for vaccination. The income of the farmer was the money obtained by the sale of cocks, hens, and growers.

After the intervention programme

- *Treatment farms:* The costs of the programme were the expenses the farmer would incur on vaccinations against Newcastle disease and Fowl pox, the labour cost for vaccinations, and the cost of drugs. The income of the farmer was the money obtained by the sale of cocks, hens, and growers.
- *Control farms:* The costs of the programme were the expenses the farmer would incur on vaccination against Fowl pox and the labour cost for vaccinations, and the cost drugs. The income of the farmer was the money obtained by the sale of cocks, hens, and growers.

Determination of reproductive performance of the birds

Four randomly selected laying hens on each farm were leg-banded and monitored for their individual reproductive performance and the following information was collected as from June 2001.

- Number of eggs laid
- Number of eggs incubated
- Number of chicks hatched and date of hatching

Chicks that were hatched from the four hens were followed for a period of six weeks to determine chick survivability at the end of the six weeks.

Blood collection and serum preparation

2.5 to 3 cc of blood were collected from six adult birds on each farm, and serum was separated from the whole blood after keeping the syringe upright in the fridge at +2 to + 8° C overnight. The serum was then stored at –20° C.

Serum was prepared from blood collected from birds in both Treatment and Control groups as follows:

Treatment farms

- *1st collection:* Before distribution of vaccines and one week before the start of vaccination programme (Pre-vaccination).
- *2nd Collection*: 45 days after first vaccination.
- *3rd Collection*: 90 days after the second vaccination (re-vaccination), that is, 180 days after the start of the vaccination programme.

Control farms

- Blood was collected before the single vaccination, and then at 45 and 180 days following the only vaccination that was given to the flocks.

Serological tests

Serological tests were conducted on 549 serum samples, by the Indirect Enzyme Linked Immunoassay (ELISA) technique, for the detection of chicken antibodies to Newcastle disease virus. The Bench Protocol Version - NDV 1.01 of August 2002 supplied by the International Atomic Energy Agency was used.

Detection of haemoparasites

Blood smears were made from the blood of two birds on each farm at the time of blood collection once every 3 months. A total of 162 smears were made and examined for the detection of haemoparasites after staining with Giemsa stain as described by Benbrook and Sloss, 1961 [2].

Interventions - Phase 2

Phase 2 extended over a period of 6 months in Zone II (Rodrigues), from October 2002 to March 2003, and the interventions were made on 12 of the same farms of Phase I, as three farms had dropped out. The farms were divided into a Treatment group of eight farms and a Control group of four farms, respectively, as shown in Table II.

The interventions of Phase 1 namely, vaccination against Newcastle disease and Fowl pox, control of parasitic helminths and coccidia were maintained. The anthelmintic and anticoccidian used in Phase 1 were each substituted by another one. A broad spectrum anthelmintic with Levamisole base and an anticoccidian with Amprolium base were administered to the flocks, at the rate of 1 g/ litre of drinking water, once every three months. Faecal samples were collected and examined once every three months before administration of the anthelmintic. 60 faecal samples were collected and analysed by the Simple Flotation Technique.

An insecticide with Carbaryl base (86%) under the trade name of Sepou, from Coophavet Co. Ltd. was administered in brooding hens or flocks whenever lice or mites affected them, by spray, at the rate of 4.5 g / 2 litre of water. The chicken house was utilised for laying, hatching and brooding on the Treatment farms.

RESULTS AND DISCUSSION

Flock size and structure

Phase 1 Zone I (Mauritius)

At the beginning of the interventions in June 2001, the number of chickens on the farms was in the range of 14 and 95, and on an average 38.3 per farm. At the end of ten months, the number of chickens ranged between 20 and 85 and was on an average 41.4 per farm as shown in Table III.

TABLE III. FLOCK STATUS IN ZONE I — MAURITIUS. (JUNE 2001–MARCH 2002)

Average number of birds/ farm	Cocks	Hens	Growers	Chicks
June 2001	7.1	14	9.9	7.1
March 2002	6.0	19.3	9.6	6.3
Dead over a period of 10 months	1.6	2.8	9.5	24.5
Sold over a period of 10 months	1.5	0.6	0.8	0
Consumed over a period of 10 mths	3.8	1.6	10	0

Zone II (Rodrigues)

At the beginning of the interventions in June 2001, the number of chickens on the farms was in the range of 10 to 488 and an average 91.8 per farm. At the end of nine months, the number of chickens ranged between 27 and 430, with an average of 92.1 per farm as shown in Table IV.

TABLE IV. FLOCK STATUS IN ZONE II — RODRIGUES. (JUNE 2001–MARCH 2002)

Average number of birds/ farm	Cocks	Hens	Growers	Chicks
June 2001	3.21	18.5	28.1	41.9
March 2002	3.14	21.8	39.1	28.1
Dead over a period of 9mths	0.8	2.3	5.2	117
Sold over a period of 9mths	0.3	6.0	26.7	0
Consumed over a period of 9mths	2.1	28.0	0	0

The evolution of the flock structure throughout the period of nine months is illustrated in Fig. 1.

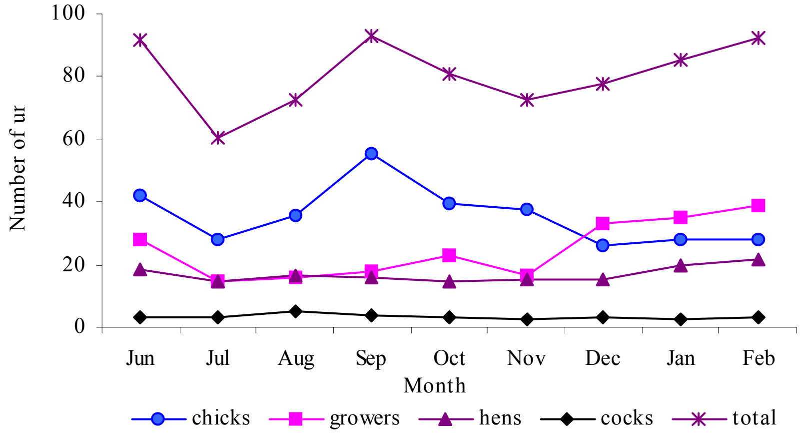


FIG. 1. Evolution of the flock structure (Phase 1 – Zone II)

In both Zones I and II, the number of adult cocks and hens was rather stable compared to that of chicks and growers, as they were kept for breeding purposes. The variation in the number of growers was mainly due to these being sold at different periods, while that of chicks was due to periodic hatching and mortality throughout that period.

The ratio of adult cock to hen per farm was 1 to 3 in Zone I and 1 to 6.3 in Zone II (compared to an average of 3.8 for the African countries), as quoted by Goodger et al, 2002 [5]. It was thus inferred that more young males were sold as compared to hens, which were kept for reproduction. Besides, young cocks fetched a better price than the other birds.

Flock size and structure : Phase 2 - Zone II Rodrigues

At the beginning of October 2002 the number of chickens on the 12 farms was in the range of 15 and 151, and on an average 96.8 per farm. At the end of the six months, in March 2003, the number of birds on the farms was in the range of 5 to 75 and was on an average 53.6 per farm. The drastic drop in the number of birds in March 2003 was due to losses of birds owing to a cyclone which hit the island during that month. The flock status and structure, and the evolution of the flocks during the six months' period are given in Table V and 5 A, and illustrated in Fig. 2.

TABLE V. FLOCK STATUS IN ZONE II. (OCTOBER 2002 TO MARCH 2003)

Average no. of birds / farm	Cocks	Hens	Growers	Chicks
October 2003	3.25	21.5	31	56.9
March 2003	2.3	11.8	26.4	28.8
Dead over a period of 6 months	3.2	11.3	45.1	87.9
Sold over a period of 6 months	1	15	56.3	0
Consumed over a period of 6 months	11.8	24	0	0

The ratio of adult cock to hen was 1 to 6.3, as in Phase 1. More cocks were consumed in Phase 2. Sales of hens and growers were also relatively more in Phase 2.

TABLE V. EVOLUTION OF THE FLOCK STRUCTURE. (OCTOBER 2002 TO MARCH 2003)

Ave. number of birds per farm	Month Oct.	Nov.	Dec.	Jan.	Feb.	Mch.
Cocks	3.6	3.3	3.3	3.1	2.8	2.7
Hens	21.5	20.1	19.1	17.1	2.5	1.6
Growers	28.6	29.9	40.1	26.5	44.9	26.4
Chicks	56.9	36.4	59.9	57.77	51.3	22.2
Flock average	96.8	72.0	98.6	88.5	104.7	53.6

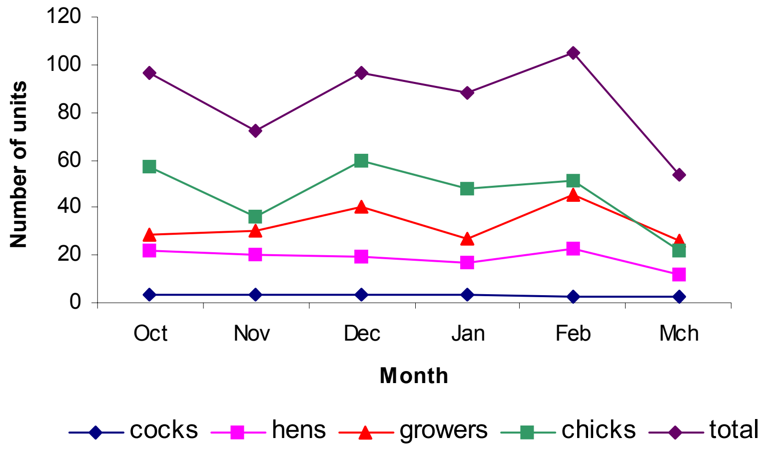


FIG. 2. Evolution of flock structure- Zone II (October 2002 – March 2003)

Housing

All the farmers in both zones utilized the materials given to them for the construction of a chicken house or for improving the existing ones during Phase I. 75% of the farmers constructed a chicken house as was designed, as shown in Fig. 3. The remaining 25% of the farmers in both zones utilized them for improving the existing shelters, making provision especially for laying, and brooding. However, the birds were allowed to roam in the farmyard for scavenging in both zones in Phase 1. The house was put to use on all the farms in September 2001. All brooders were housed at night in both zones. Growers and adults perched partly in the house, but mostly outside, on trees and shrubs. In the sixth month of Phase 2 in Zone II, 75% of the chicken houses were completely blown down during a strong cyclone.

FIG. 3. Low cost chicken house in Zone II

Mortality

No disease outbreak of disease was reported during the study in both zones, and in both Phases; Newcastle disease was notably absent.

Phase 1: Mortality was mostly in young chicks and in both zones, as shown in Tables III and IX. The causes of deaths in the chicks were mainly predation and stress conditions. Sporadic deaths due to Fowl pox occurred on two farms in Zone II. The mean mortality rates of birds on the farms in the Treatment and Control groups were 43.7 ± 8.9% and 45.3 ± 5.8 % respectively in Zone I, and were 40.5 ± 17.6% and 45.2 ± 9.1% respectively, in Zone II.

Phase 2: Mortality during the six months of the second phase in Rodrigues was 47.9 ± 37.7% and 9.3 ± 5.4% in the Treatment and Control groups respectively (Table VI). No disease outbreak was reported, but a large number of birds died during a cyclone in the last month of the interventions.

TABLE VI. MORTALITY OF BIRDS ON THE FARMS.

Phase	Zone	Farms	Mortality (%)		
			Range	Mean	S.D
Phase 1	I-Mauritius	T (8)[1]	35.1–57.9	43.7	8.9
		C (4)	38.1–51.8	45.3	5.8
	II-Rodrigues	T (10)	16.4–75.0	40.5	17.6
		C (5)	35.7–58.1	45.2	9.1
Phase 2	II-Rodrigues	T (8)	9.3–53.4	47.9	37.7
		C (4)	4.3–17	9.3	5.4

[1] Number of farms

Reproductive performance of the birds

After monitoring the reproductive performance over a period of 10 months in Zone I and for 9 months in Zone II, it was found that a hen had on an average four clutches per year (as compared to an average of three for African countries (Goodger et al, 2002) [5]. 13 to 14 eggs were laid in one clutch, 10 to 13 eggs were set for incubation, and 8 to 10 chicks were hatched. Eggs from different hens were often mixed for incubation, and farmers avoided setting their eggs in winter. They claimed that incubated eggs get spoilt during cyclonic weather.

Hatchability was found to be 75% in Zone I and 81% in Zone II on average (Table VII).

TABLE VII. REPRODUCTIVE PERFORMANCE OF THE 'LOCAL' CHICKENS.

Average	Zone I		Zone II	
	T	C	T	C
No. of clutches/hen/year	4	4	4	4
Number of eggs laid	14 (1.2)[1]	14 (3.5)	13 (2.6)	13 (1.4)
Number of eggs incubated	12 (2.4)	10 (1.1)	13 (3.9)	12 (1.6)
Number of eggs hatched	9 (1.3)	8 (0.5)	11 (4.6)	10 (1.3)
Hatchability (%)	75 (7.5)	80 (8.0)	84 (7.9)	83 (4.0)

[1] Standard deviation

Survivability of chicks

In Phase 1, the chicks were monitored for six weeks from their hatching date, as during this period they are most fragile and very susceptible to diseases and predators. It was found that in both Zones I and II and on both Treatment and Control farms, the rate of mortality decreased with the age of the chicks, and was getting stabilized after six weeks, as shown in Fig. 3.The mean mortality rates during the first six weeks of age in the Treatment and Control groups were 27.3 ± 23.6% and 45.3 ± 5.8 % respectively in Zone I, and 36.4 ± 21% respectively in Zone II.

At the age of 6 weeks, survivability rate was 50% and 52%, in the Treatment groups in Zone I and II respectively, compared to 44% and 24% in the Control groups, respectively (Table VIII). The survivability of the chicks from hatching to six weeks of age in both zones is illustrated in Fig. 4.

TABLE VIII. SURVIVAL RATE OF CHICKS FROM HATCHING TO SIX WEEKS OF AGE.

	Survival rate (%)						
	Age (wks)	1	2	3	4	5	6
Zone I	T	77	73	66	58	54	50
	C	62	55	50	50	47	4
Zone II	T	91	80	72	60	56	52
	C	86	70	50	35	26	24

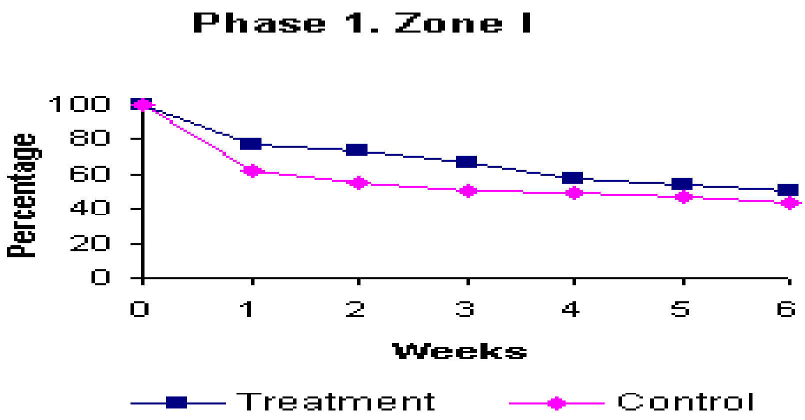


FIG. 4a Chicks survival rate from hatching to six weeks of age

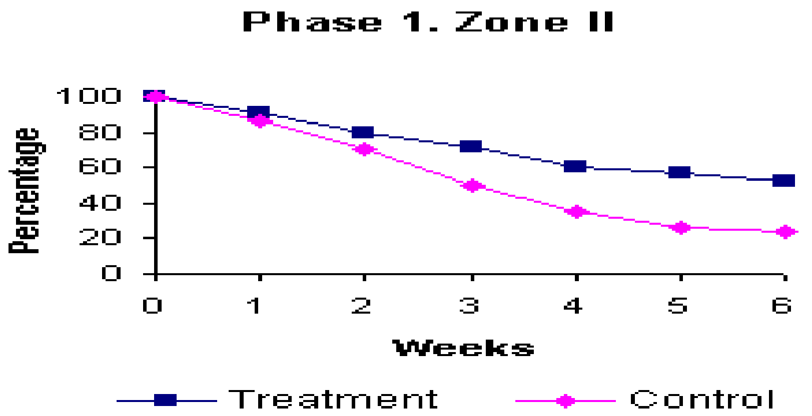


FIG. 4b. Chicks survival rate from hatching to six weeks of age

Feeding and costs of feeding

In both Phase I and Phase 2 and in both Zones I and II, the birds were allowed to scavenge on all the farms. While scavenging, the birds ate mainly grass, insects and worms, which were moderately available throughout the year. They were also given supplements like concentrate, rice, maize, bread and sweet potatoes. Concentrate was fed on 83 % of farms in Zone I and on 100 % of farms in Zone II as shown in Table IX.

The percentage of farms that gave the different types of feeds in both zones and in each phase is given in Table IX. The contribution of the different feed types in the feed cost in each zone is illustrated in Figures 7 and 9, respectively.

TABLE IX. FEEDING PRACTICES AND CONTRIBUTION OF DIFFERENT FEED TYPES IN THE FEED COST.

Feed type	Phase 1 Zone I		Zone II		Phase 2 Zone II	
	% Farms	Contribution to feed cost % (Av)	% Farms	Contribution to feed cost % (Av)	% Farms	Contribution to feed cost % (Av)
Concentrate	83	79	100	62.4	100	80
Rice	41	12	93	24.2	25	7.7
Maize	8	5	53	9.5	41.6	9.7
Bread	33	4	27	4.0	8.3	2.2

The feeding practice was quite different in the two phases, but the contribution of the different feeds in the feed cost was nearly the same. There was a decrease in the feeding of rice which is normally the cheapest feed, both on the number of farms and in its quantity, in Zone II during Phase 2, but at the same time, the feeding of concentrate was maintained on all the farms. The contribution of concentrate in the feed cost was thus increased to 80%.

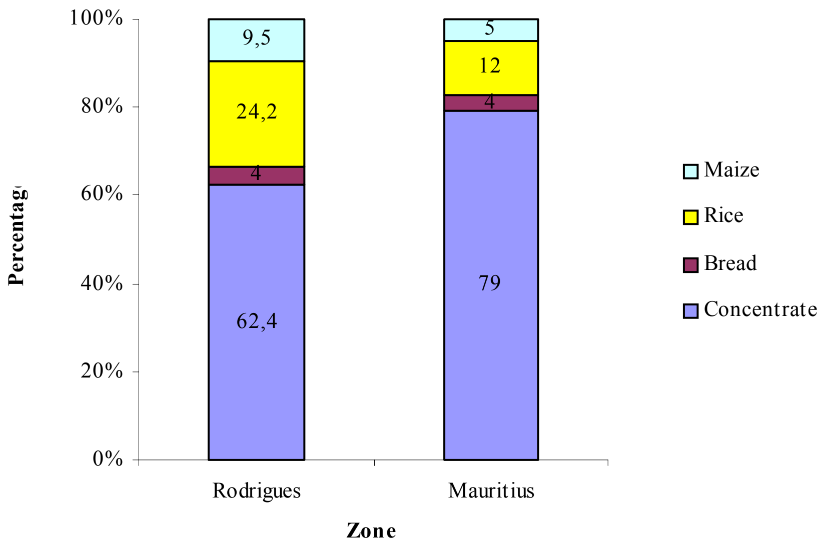


FIG. 5. Contribution of different feeds in the feed cost-In Zones I and II (Phase 1)

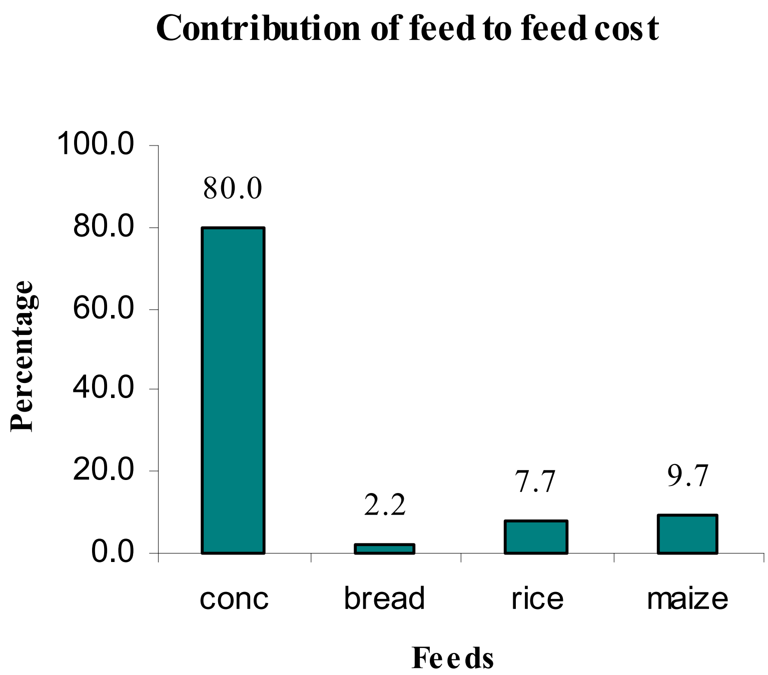


FIG. 6. Contribution of different feeds in the feed cost -Zone II, Phase 2.

Cost of feeding (Phase 1)

The amount of money spent yearly by farmers on feeds was in the range of Mauritian rupees (MUR) 712 to MUR 24,694 with an average of MUR 6,673 in Zone I, and MUR 2,063 to MUR 23,625 with an average of MUR 7,084 in Zone II, respectively. The contribution of the different feeds in the feed cost is illustrated in Fig. 5.

Cost of feeding (Phase 2)

The amount of money spent yearly by farmers on feeds in Phase 2 in Zone II (Rodrigues), was in the range of MUR 740 to MUR 18,4 00 with an average of MUR 5,547. The contribution of the different feeds in the feed cost is illustrated in Fig. 6.

Disposal of chickens and eggs

Cocks, hens and growers as well as eggs were both consumed and donated on almost all the farms and in both zones. Chickens and eggs were sold on 50% of farms in Zone I. The eggs were sold to neighbours while chickens were sold to itinerant salesmen.

In Zone II chickens and eggs were sold on 80% and 46% of the farms, respectively. The eggs were sold in the same village, while chickens were sold mostly to itinerant poultry merchants. The poultry merchants exported these ‘local’ Rodriguan chickens live by ship to Mauritius. 26,100 of these birds were exported on an average each year to Mauritius during the past decade (Fig. 7) (Anon, 2001) [6].

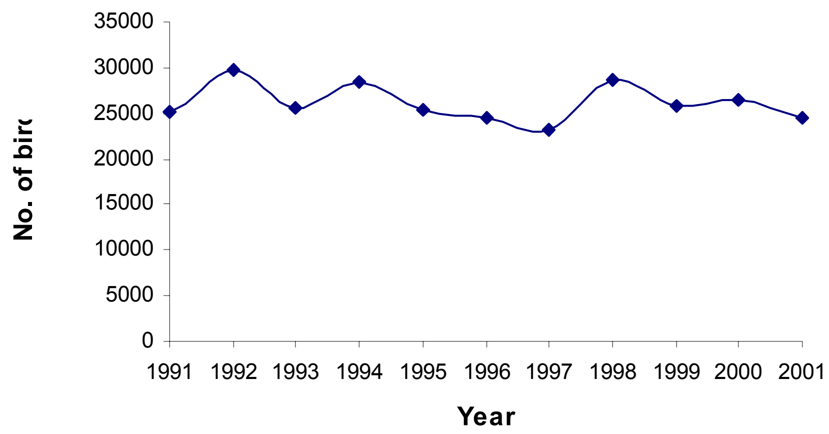


FIG. 7. Export of chickens live to Mauritius

Revenue, profit, and return obtained as a result of interventions

An assessment of the economic performance of the farms was made by calculating the ‘return’ of the farmer. The additional income that was derived as a result of the interventions was the difference between the income obtained after the interventions less the income that was obtained before the intervention programme started. The profit was the additional income minus the intervention costs, and the ‘return’ obtained was the profit divided by the intervention costs. The criteria that were used in the calculation of the return were as follows:

- Input was all additional expenses related to the intervention programme namely, costs of vaccines, anthelmintics, anticoccidians, insecticide and vitamins, and cost of labour for vaccination.
- The output was the income that was generated from the number of cocks, hens and growers that were sold as a result of the interventions.

- Assumptions were used, viz:
- A cock, a hen, and a grower represented 1.5, 1.0 and 0.75 unit respectively.
- The average assumed market value of a cock, hen and grower was MUR 193, 130 and 98, respectively (1 US $ = 29 Mauritian rupees)
- The unit value of a chicken that was sold, donated or consumed was MUR 130 on an average.
- The unit market value of egg sold, donated or consumed was MUR 2.50 on an average
- As the calculation of return obtained requires data for 12 months, the available data was standardized to a period of one year.
- In Phase 2, the total revenue that the farmer obtained from farm produce was calculated taking into account the following :
- The'cash' income was that derived from the sale of chickens and eggs
- The non-cash income was the monetary value of donations and home consumption of chickens and eggs
- The total revenue of farmers who utilized the chicken house for brooders was compared to that of those farmers who did not utilize it for this purpose.
- The cost of materials for the chicken house as well as cost of construction, vaccination, and drugs made up the total costs of the interventions.
- The feed costs were included in the expenses for computing the profit and return of the farmer.
- The element of depreciation of the chicken house valued at 5% annually.

Return obtained and partial budgeting

Phase 1 Zone I (Mauritius)
Treatment farms

The total average costs of the intervention programme per farm per year were $ 10.7, as compared to $ 6.5 before the programme was implemented. The average additional income that was generated with the sale of adult birds as a result of the programme was $ 56.1 per farm per year, and the annual average return was calculated to be $ 4.2 for every dollar that was invested.

Control farms

The total average costs with vaccination against Fowl pox and the control of endoparasites, but without a vaccination programme against Newcastle disease, was on an average $ 8.8 per farm per year, as compared to $ 1.4, when only a single vaccination against Newcastle disease was given before the interventions. The income that was generated at the end of this intervention was on an average, $ 14.9 per farm per year. The return was on an average 0.7 per year.

Phase 1 Zone II (Rodrigues)
Treatment farms

The total costs of the intervention programme were on an average $ 10.7 per farm per year, as compared to $ 6.5 before the programme. The average additional income that was generated from the programme was $ 74.8 per farm per year. The annual return was calculated to be on an average 6.0 per farm per year, for every dollar that was additionally invested.

Control farms

The total average costs with vaccination against Fowl pox and the control of endoparasites, but without a vaccination programme against Newcastle disease, was on an average $ 8.6 per farm per year, as compared to $ 1.6, when only a single vaccination against Newcastle disease was given before the interventions. A loss of $ 20.7 per farm per year was registered, and a loss of $ 3.4 occurred for every dollar that was invested.

A summary of the return or loss sustained by the farmers in both zones is given in Table X.

TABLE X. RETURN ON INVESTMENT WITH THE INTERVENTION PROGRAMME. (PHASE 1: JUNE 2001 TO MARCH 2002)

Zone	Farms	Income from sale of adult birds/farm/yr (US $)		Add. income generated from the prog./farm/yr (US $)	Intervention costs /farm/yr[1] (US $)	Profit/ farm/yr (income) (US $)	Return/farm/yr (US $)
		Before int.	After int.				
	T[2](n=8)	32.5	88.6	56.1	10.7	45.4	4.2
I	C[3](n=3)	32.9	47.8	14.9	8.8	6.1	0.7
II	T(n=8)	26.9	101.7	74.8	10.7	64.1	6.0
	C(n=4)	112.1	91.4	- 20.7	8.6	- 29.3	- 3.4

1. - Costs of ND and Fowl vaccines, Labour costs to give vaccines, Antiparasitic drugs on Treatment farms
- Costs of Fowl vaccine, Labour costs to give vaccine, Antiparasitic drugs on Control farms
2. Treatment farms
3. Control farms

Phase 2, Zone II – Rodrigues

Farm income and return after interventions including housing of ***chicks***

Treatment farms

On the treatment farms where the chicken house was utilised by brooding hens and chicks, the total costs of the interventions, including housing and depreciation on housing, vaccination, anthelmintic, anticoccidian, insecticide, amounted to $ 79 per year, on an average. The income derived from the sale of adult birds was $ 126. The profit was thus, $ 47 and the return was 0.6, for every additional dollar invested in the programme.

Control farms

On the Control farms where the brooding hens were left free in the yard, $ 45 was obtained from the sale of adult birds, while the costs of the interventions were $ 79. Thus, the farmer made on an average a loss of $ 34 per year, and lost 0.43 on every dollar invested in the programme.

A summary of the return or loss sustained by the farmers in both zones in Phase 2, is given in Table XI.

Overall monetary value obtained from farm produce

Treatment farms

The value of chickens and eggs that were consumed and donated amounted to $ 128, and the income derived from the sale of adult birds was $ 126. Considering the cost of feeds which was on an average $ 101.7 per farm, and the costs of interventions, the farmer obtained on an average, a yearly net monetary value of $ 73.3 from farm produce.

TABLE XI. FARM INCOME WITH THE HOUSING OF BROODING HENS AND CHICKS. (PHASE 2 ZONE II — RODRIGUES)

Farms	Sale of adult birds (US $)	Cost of interventions: Item	Cost US ($)	Total int. Costs (US $)	Profit (US $)	Return (US $)
Treatment (n=6) (Brooders housed)	126	ND vaccine	1.8	79	47	0.6
		Fowl pox vaccine	0.7			
		Labour cost to give vaccines	4.7			
		Anti-parasitic drugs	8.4			
		Housing (materials, construction and maintenance)	60.8			
		Depreciation	3.0			
Control (n=4) (Brooders not housed)	45	ND vaccine	1.8	79	- 34	- 0.43
		Fowl pox vaccine	0.7			
		Labour cost to give vaccines	4.7			
		Anti-parasitic drugs	8.4			
		Housing (materials, construction and maintenance)	60.8			
		Depreciation	3.0			

Control farms

The value of chickens and eggs that were consumed and donated, amounted to $ 124, and $ 45 was obtained from the sale of adult birds. Considering the cost of feeds which was on an average $ 147 per farm per year, and the costs of interventions, the farmer lost on an average, a monetary value of $ 57 per year.

Parasitic infestations

Effect of the anthelmintic and anticoccidian on endoparasitic infestations

Phase 1.

Examination of faecal samples before the first administration of the anthelmintic “Piperal” and the anticoccidian “Anticoc” in Phase 1 revealed that birds on 25% of farms had a low infestation (+) with helminthes parasites of *Ascaridia galli*, and that birds on 33% of farms had a low (+) infestation with coccidia of *Eimeria* species, in Zone I. In contrast, in Zone II, besides a low infestation with coccidia on 20% of farms, there was a high infestation (+++) with *Strongyloides avium*

Examination of faecal samples three months after two successive administration of the drugs revealed that there was no re-infestation with endoparasites in Zone I. A low level of re-infestation with the helminthe parasites *Strongyloides avium* and *Heterakis gallinarum* was observed on 6% and 26% of farms respectively, after the second application of the drugs in Zone II. A low level of re-infestation with *Strongyloides avium* however, persisted after a second application, as shown in Table XII.

TABLE XII. RESPONSE OF FLOCKS TO TREATMENT WITH ANTHELMINTIC AND ANTICOCCIDIAN.

Period (months)	Species	Phase 1- Zone I Infection rate*	% farms	Species	Phase 1 -Zone II Infection Rate	% farms
0	*Ascaridia galli*	+	25	*Asccaridia galli*	+	6
	Coccidia	+	33	*Heterakis gallinarum*	+	26
				Strongyloides avium	+++	13
				Syngamus trachea	+	6
				Coccidia	+	20
3	Nil	0	100	*H. Gallinarum*	+	26
				Strongy loides avium	+	6
6	Nil	0	100	*Strongyloides avium*	+	6

*+ Low No haemoparasite was detected in the blood smears made in any of the two zones.
++ Mild +++ High Nil No infection

Phase 2.

The monitoring of endoparasitic control in Phase 2 in Zone II, Rodrigues, by the application of another anthelmintic “Levalap” and anticcidian “Amprol” and faecal examinations revealed occasional re-infestation with *Ascaridia galli* on 6% of farms after the first treatment, and no re-infestation by helminthes or coccidian parasites on any farm at the third and sixth month.

Piperal and Anticoc were substituted by Levalap and Amprol respectively in order to avoid the development of drug resistance by the parasites.

Effect of insecticide on ectoparasitic infestations

A low level (+) of ectoparasitic infestation with lice was observed on 20% of farms in Zone 1, while a moderate level (++) was observed on 46%of farms in Zone II. The lice were identified as *Menopan gallinae* species. Deaths due to lice infestation was reported on two farms in Zone II during Phase 1.

Farmers were reported to have utilized Carbaryl on brooding hens whenever the need arose. Lice infestation was not detected during visits. This was an indication that lice and mites were being effectively controlled.

Response of birds to vaccination

Vaccination against Newcastle disease

The majority of farmers did not vaccinate their day old chicks by the intra-ocular route in the treatment groups, as they found it difficult. Instead, they vaccinated them via drinking water by reconstituting one vial of 100 doses of the vaccine in about 200 ml of water. They often vaccinated the chicks when they were several days old.

Owing to cyclonic conditions, electricity supply was cut off for several days in both zones. Thus, both vaccines and reagents were exposed to room temperature which could have reached up to 30 ºC. 175 samples were found to be contaminated and were discarded.

Immunity status of the birds before the vaccination programme started

Serological tests showed that prior to the start of the vaccination programme (Pre-vaccination), the birds were having a level of antibodies against Newcastle disease virus in the range of 8.2% to 26.4%, and a mean of 16.1 ± 5.2% in Zone I. In Zone II, the level was in the range of 13.6% to 19.2%, with a mean of 16.0 ± 2.7%. When the birds were divided into Treatment and Control groups for the interventions, the birds in the Treatment group showed a mean antibody level of 16.2 ± 5.2, and a mean of 15.6 ±2.7 in the Control group in Zone I, while In Zone II it was 16.6 ±1.8 and 15.6 ±3.1 in the Treatment and Control groups respectively.

Immunity status of the birds 45 days post-vaccination

Control group:

After around 45 days following a single flock vaccination serological tests revealed that the birds had produced antibodies against Newcastle disease virus in the range of 26.6% to 59%, with a mean of 38.6 ± 17.7% in Zone I, and was in the range of 13.8% to 28.5%, with a mean of 18.2 ± 5.9% in Zone II.

Treatment group:

After around 45 days of the first vaccination of flocks by the oral route, and also of all hatched chicks in the Treatment groups, the level of antibodies produced were on an average, 34.6 ± 9.2% in Zone I, with a peak of 50.2%. In Zone II it was on an average, 29.6 ± 9.5%, with a peak of 40.8%

Immunity status of the birds 90 days post-vaccination

Control group:

After around 90 days following re-vaccination, that is, 180 days after start of the vaccination programme, the mean levels of antibodies detected were 17.3 ± 3.2% and 19.9 ± 4.7% in Zones I and II, respectively.

Treatment group:

The mean levels of antibodies detected were 17.3 ± 3.2% and 19.9 ± 4.7%, with peaks of 30.7% and 40.7%, in Zones I and II, respectively.

It was observed that the level of antibodies in the sera of birds from the control groups of both zones were much lower than those in the treatment group, as shown in Table XIII.

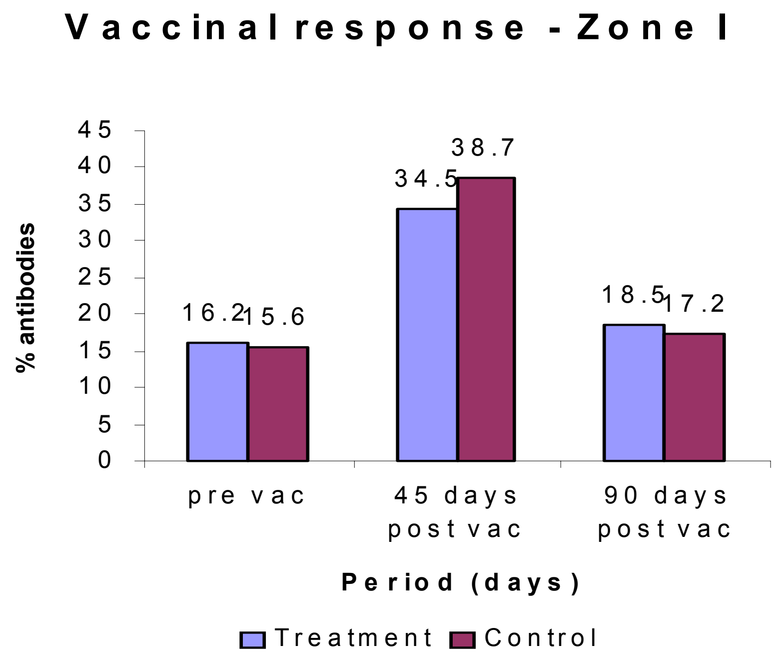
It was also observed that by vaccinating a flock of birds against Newcastle disease once every three months and by the oral route, an adequate level of immunity was not achieved, as the minimum level of antibodies to resist an attack of the disease was benchmarked at 30%.

TABLE XIII. ANTIBODIES PRODUCED AGAINST NEWCASTLE DISEASE VIRUS.

		Pre-vaccination* % Antibodies		45 days Post Vaccination		90 days Post Vaccination	
		Range	Mean	Range	Mean	Range	Mean
Zone I Mauritius	Treatment	8.2–26.4	16.2 (5.2)**	24.4–50.2	34.6 (9.2)	11.1–30.7	18.6 (5.0)
	Control	8.6-22.2	15.6 (2.7)	26.6–59	38.6 (17.7)	13.4–21.6	17.3 (3.2)
Zone II Rodrigues	Treatment	14.0-19.1	16.6 (1.8)	14.9–40.8	29.6 (9.5)	16.8–40.7	24.4 (7.4)
	Control	13.6-19.2	15.6 (3.1)	13.8-28.5	18.2 (5.9)	16.6–23.3	19.9 (4.7)

*Before the start of vaccination programme ** Standard deviation

The response or the birds to vaccination in both zones is illustrated in Fig. 8.



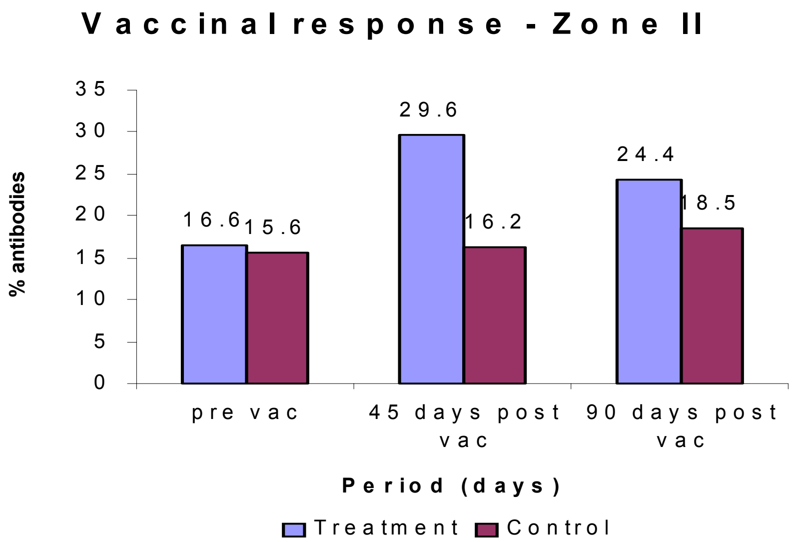


FIG. 8. Response of the birds to vaccination against Newcastle disease

Vaccination against Fowl pox

Fowl pox was reported to occur sporadically on only two farms in Zone II, and during Phase 1 only. Sporadic deaths of chicks occurred on those farms.

CONCLUSION

- A low-cost housing was essential especially for hens to incubate eggs, and for chicks to be protected from predators and environmental hazards thereby increasing the survivability of chicks. As cyclones are always a threat to low-cost poultry shelters the present one needs to be consolidated, but would require more investment on the part of the farmers. However, the farmers should not confine their chickens permanently, as these birds are semi-scavenging ones.
- Farmers should limit the feeding of commercial concentrate feeds to their laying hens and chicks, and should utilize cheaper supplements like rice, maize and green vegetables, in order to reduce their feeding cost. A reduction in the feeding cost would increase their return.
- Parasitic infestations were not of major importance as the birds controlled these naturally. However, a systematic prophylactic treatment against both endoparasites and ectoparasites would further reduce the risks of re-infestations.
- Although no outbreak of these diseases was reported during the intervention periods in both zones, and no clinical cases were reported, vaccination of family poultry against Newcastle disease and Fowl pox must be maintained.
- The vaccination programme was relatively effective, although an optimum immunity against Newcastle disease was not conferred to the birds through vaccination. This could be attributed to a decrease of potency of some reagents as well as of vaccines, as these were exposed to temperatures exceeding room temperature for several days, as a result of power cut during cyclonic weather. The vaccination programme against Newcastle disease would have been more effective if the farmers had vaccinated their individual birds by the ocular route, as this method of vaccination is known to be more effective.
- Family poultry production was not of importance in Mauritius, whereas it was of importance in Rodrigues for its contribution towards the home consumption of chicken and egg, and in the generation of additional income to the farmer.
- The constant trend of the export of the “local” Rodriguan chickens live to Mauritius during the past decade was an indication of a guaranteed market for this commodity in Mauritius. There was, therefore, a need to provide adequate support to the family poultry farmers so that they could increase their farmyard poultry production.

ACKNOWLEDGEMENTS

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A GUIDE TO IMPROVE FAMILY POULTRY PRODUCTION IN MAURITIUS

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INTRODUCTION

In order to produce a guide for farmers in Mauritius, key issues of backyard poultry production were discussed and the following short version of recommendations was compiled to be used in a leaflet for farmers.

Guide for improved backyard poultry production

Smallholder poultry farmers in Mauritius and Rodrigues can increase the production of their 'local' chicken and egg, and see their return increase by taking the following measures:

- Vaccination of their birds
- Control of parasitic infestations in their flock of birds
- Provision of a shelter to their chickens

Vaccination

The birds have to be vaccinated against two very important diseases caused by viruses, namely against Newcastle disease and Fowl pox. Both diseases usually affect chickens in the dry winter season. Newcastle disease can kill almost all the birds on the farm, while Fowl pox affects young birds.

Farmers can vaccinate their birds as follows:

Vaccination against Newcastle disease

The vaccine used commonly is the NDV 4 vaccine, which can be obtained from any of the district veterinary centres. The vaccine is in a powdered form, and is presented in vials. One vial contains 200 doses, and is meant for 200 birds. It is presently sold at Rs.5.25 a vial. It must be carried in a thermos flask preferably and stored at +2 to +8º C in the refrigerator, if not used immediately.

Vaccination schedule:

- **All day old chicks:** 1-2 drops of vaccine diluted in about 20 ml. of water, in the eye, by means of a dropper (intra-ocular route)
- **Rest of flock:** Reconstitute one vial in 1.5 litres of previously boiled and cooled water, and give for drinking in the morning.
- **Revaccination:** Repeat vaccination of the flock regularly once every three months

Vaccination against Fowl pox:

The vaccine is obtained in 50 and 100 doses at Rs.5.25 for a vial 100 doses. Vaccinate all chicks at 21 days of age, in the thigh by dipping a needle in the vaccine vial and pricking the skin. The vaccine must be carried in a thermos flask preferably and stored at +2 to +8º C in the refrigerator, if not used immediately. Vaccinate twice a year.

Control of parasitic infestations

Worm infestation:

Give a broad spectrum anthelmintic in drinking water once every three months. This is easily available from Drug stores Follow the instructions of the manufacturer so as to give the correct dose.

Lice and Mite infestation:

Spray an insecticide in the chicken house, or on individual infested birds during brooding.

Provision of a shelter to their chickens

Construct a shelter for the chickens, especially for chicks as it is important to protect them during the night. The eggs can be hatched in the house. The chicks should be kept in the shelter till six weeks of age. The chicks should be fed creep feed after separating them from the hen.

EFFECTS OF FEEDING, HOUSING AND ANTIPARASITIC TREATMENTS IN IMPROVING FREE RANGE CHICKEN PRODUCTION IN MOROCCO

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Abstract

The objective of this work was to determine the effects of feeding, housing and anti-parasitic treatment on the improvement of family poultry production in Morocco. Eight free range chicken flocks were partitioned into 2 groups; «intervention» and «no intervention» flocks. In "Intervention" flocks, locally made brooders and poultry houses were provided, the birds received supplementary feeding and were subjected to anti-parasitic treatment against endo-parasites and ecto-parasites. Both categories of flocks were vaccinated against Newcastle disease and Gumboro disease. Data relative to flock size and structure, mortality, egg production, chicken and egg sales, sale prices, feed consumption were collected at a bi-weekly to monthly basis from July 2002–July 2003 and were subjected to appropriate statistical comparisons of proportions and means. Flock size and structure and flock and egg production was significantly improved in «intervention» flocks. Mortality of young birds (Chicks and cockerels/pullets) in «intervention» flocks was significantly lower than in «no intervention» flocks. The cost-benefit analysis has shown that «intervention» flocks have made better profit. The mean relative profit (output/input ratio) in «intervention» flocks was 3.65 and only 2.55 in «no intervention» flocks. These results indicate that the performed interventions had an overall beneficial effect on the studied parameters.

INTRODUCTION

Moroccan poultry production plays a vital role in narrowing the animal protein supply-gap (Benabdeljalil, 1997). Most of this production is fulfilled by the commercial sector which is concentrated around large urban areas. The remote areas rely mainly on small-scale poultry and traditional family poultry production.

Family poultry or the so locally called "Beldi poultry " is an integrated component of nearly all rural households. Besides providing valuable proteins, it generates incomes particularly to women the main managers of Moroccan family poultry. Despite this, it is very precarious and permanently threatened by diseases such as Newcastle disease (NCD) and Gumboro disease (Bell J.G. 1986, Mouloudi S. 1987, Kichou F. *et al.* 2002a). Previous results from field surveys have shown that free range chickens in Morocco experience heavy losses through mortality mainly among young chickens (infectious diseases and predators, malnutrition and underfeeding, parasitic infestation particularly with ecto-parasites, and poor housing conditions (Kichou F. *et al.*, 2002b).

The purpose of this work was to evaluate the economical benefits of interventions triggered in order to improve family poultry production in Moroccan conditions such as feeding, housing and anti-parasitic treatment.

MATERIAL AND METHODS

Flocks

Eight free ranging chicken flocks were chosen, according to the cooperation of owners and easy access, in a village from a remote area north-west of Morocco. The flocks were partitioned into 2 groups: a 1st group of 4 *«intervention»* flocks (with interventions) and a 2nd group of 4 *«no intervention»* flocks used as controls (with no interventions). The flock size and structure of these study flocks are summarized in Table I.

TABLE I. FLOCK SIZE AND STRUCTURE OF STUDY FLOCKS.

Groups/Flocks		cockerels/pullets 2-5 months	5-7 months	total	Hens	Cocks
«intervention» flocks	I	16	0	16	14	8
	II	4	0	4	9	5
	III	0	10	10	18	7
	IV	8	0	8	4	2
	Total	28	10	38	45	22
	Mean	7	2.50	9.50	11.25	5.25
«no intervention» flocks	V	2	0	2	7	2
	VI	0	8	8	6	3
	VII	6	7	13	8	1
	VIII	9	0	9	6	1
	Total	17	15	32	27	7
	Mean	4.25	3.75	8	6.75	1.75

Interventions

"Intervention" flocks were subjected to the following interventions:

Brooders:

Brooders were locally made using reed, a locally available material. They were designed by our research team and made by a local craftsman (Figs. 1 & 2). Each farm received three of these brooders for chicks rearing. First plan was to separate chicks from their dam and put them into the brooders but after the experiment started it was difficult to keep the chicks away from the dam and to convince the farmers to do it this way for the whole brooding period. So we were obliged to keep the brooding hens together with their chicks. Each brooding hen and chicks were kept in the brooders during the evening and during the day they were given feed and then freed by the farmer to go out and look for extra feed by themselves over a period of eight weeks. At this age, the chicks were considered as pullets and cockerels and freed with the rest of the flock.

FIG. 1. Chickens near by Locally made brooders

FIG. 2. A hen with her chicks in a brooder

Housing:

Poultry houses were made out of wooden stick, wire mesh, plastic and zinc shelters and installed on the farms (Fig. 3). Commercial drinkers and feeders (used for broilers) were purchased and made available for the chickens within the brooders and the houses.

FIG. 3. Chickens getting feed near by poultry houses

Feeding

Feed was purchased from a local feed mill and given to farmers to be distributed to the chickens as follow:

- Chicks were given mash feed *ad libitum* during the whole period of brooding until 8 weeks of age. The brooding hen was given approximately 25 g of pellet feed daily. The amount of feed distributed was recorded by farmers.
- Ranging chickens aged over 2 weeks were given feed supplement only during the period of scarce range feed resources from October 1, 2002 to March 30, 2003. In each farm, the amount of feed was calculated to give for each chicken the equivalent of 25 g per day of pellet feed considering that the daily requirement of an adult chicken is about 100 g/day (Anonymous, 1993).

Anti-parasitic treatment against

- Endoparasites using anthelmintic drugs twice. First treatment in September and the second treatment in February prior to vaccination.
- Ectoparasites 3 times during the warm periods: July-august 2002 and June-July 2003. Birds, houses and premises were thoroughly sprayed with an acaricide.

Vaccination against Newcastle disease and Gumboro disease:

In order to protect both *«intervention»* and control flocks from outbreaks of NCD and Gumboro disease, they were all vaccinated as follow:

- Vaccination against NCD was performed three times in all categories of birds (young and adult chickens) in September 2002, December 2002 and March 2003, using a live vaccine by eye drops.
- Vaccination against Gumboro disease was performed in newly hatched chicks, growers and adult chickens using a live vaccine by eye drops. In order to reach maximum coverage and protection of birds, it was applied 4 times during the study period corresponding to the brooding periods: September and November 2002 and March and April 2003.

The partition of interventions is summarized in Table II.

TABLE II. PARTITION OF INTERVENTIONS.

Groups/Flocks	Housing	Feeding	Anti-parasitic treatments		Vaccination	
			endoparasites	ectoparasites	NCD	Gumboro disease
intervention	+	+	+	+	+	+
no intervention	-	-	-	-	+	+

Data collection

Data relative to flock size and structure, mortality, egg production, chicken and egg sales and sale prices, feed consumption were collected at a bi-weekly or monthly basis from the period of July 2002–July 2003.

Statistical analysis: Data were subjected to appropriate statistical comparisons of proportions and means.

RESULTS

Flock size and structure

Flock size and structure of the investigated flocks at the beginning and the end of the experiment are depicted in Table III. Mean number of cockerels/pullets, hens and cocks in *«intervention»* flocks were 9.5, 11.25 and 5.25, respectively. At the end of experiment they were 2.50, 11.25 and 2.75. Mean number of cockerels/pullets significantly increased to reach 25 birds, whereas there was no change in mean number of hens and cocks. In *«no intervention»* flocks the mean number of cockerels/pullets, hens and cocks at the beginning of experiment were 8, 6.75 and 1.75 birds, respectively. But, these Figures did not significantly change at the end of the experiment.

TABLE III. FLOCK SIZE AND STRUCTURE OF THE INVESTIGATED FLOCKS AT END AND BEGINNING OF EXPERIMENT.

Groups/ Flocks	Periods		Number of cockerels/pullets 2-5months	5-7 months	total	Number of Hens	Number of Cocks
Intervention	at start (July 31, 2002)	Total	28	10	38	45	22
		Mean	7	2.50	9.50	11.25	5.25
	at end (July 29, 2003)	Total	56	44	100	40	11
		Mean	14	11	25	10	2.75
no intervention	at start (July 31, 2002)	Total	17	15	32	27	7
		Mean	4.25	3.75	8	6.75	1.75
	at end (July 29, 2003)	Total	26	18	44	21	4
		Mean	6.50	4.50	11	5.25	1

Flock production

Cockerel/pullet, hen and cock production was expressed as the mean number of birds produced per hen present a year (Table IV). Mean cockerel/pullet produced per hen present in *«intervention»* flocks was significantly higher than in *«no intervention»* flocks (P=0.01). 1.9 cockerel/pullet per hen present in *«intervention»* flocks versus 0.7 cockerel/pullets per hen present in *«no intervention»* flocks. Similar pattern was found for hen and cock production but without any significant difference.

TABLE IV. COCKEREL/PULLET, HEN AND COCK PRODUCTION.

Groups/ flocks		Number of hens present a year	cockerels/pullets Total produced	produced/ hen present	Cocks Total produced	produced/ hen present	Hens Total produced	produced / hen present
«intervention»	I	14.5	64	4.42	5	0.35	3	0.21
	II	8.1	23	2.83	9	1.11	9	1.11
	III	11.4	25	2.19	25	2.19	12	1.05
	IV	4.1	13	3.13	6	1.45	12	2.89
	Mean	9.5	31.3	3.1	11.3	1.3	9.0	1.3
«no intervention»	V	7.3	9	1.23	2	0.27	1	0.14
	VI	5.4	6	1.11	4	0.74	1	0.19
	VII	6.5	0	0.00	8	1.23	5	0.77
	VIII	4.0	4	1.00	2	0.50	3	0.75
	Mean	5.8	4.8	0.8	4.0	0.7	2.5	0.5

Mortality

Chick mortality

Chick mortality is given in Table V. In *« intervention»* flocks mortality of chicks varied from 18 to 25% with a mean mortality rate of 20%. Whereas, in *«no intervention»* flocks, mortality was significantly higher and reached 66% with a mean mortality rate of 56% (P=0.01).

Cockerel/pullet mortality

Cockerel/pullet mortality is represented in Table VI. This mortality varied from 4% to 23% in *«intervention»* flocks and from 23% to 34% in *«no intervention»* flocks. The mean mortality rate *«intervention»* flocks (17%) was significantly (P=0.01) higher than that in *«no intervention»* flocks (41%).

TABLE V. CHICK MORTALITY.

Groups/flocks		Total number of present chicks	Number of dead birds	Mortality rate
«intervention»	I	118	25	21%
	II	61	11	18%
	III	113	22	19%
	IV	51	13	25%
	Total & mean	343	71	20%
«no intervention»	V	74	41	55%
	VI	58	38	66%
	VII	39	17	44%
	VIII	36	13	36%
	Total & mean	207	109	56%

TABLE VI. COCKEREL/PULLET MORTALITY.

Groups/flocks		Mean Cockerels/Pullets present a year	Number of dead birds	Mortality rate
«intervention»	I	29.7	3.0	04%
	II	16.4	9.0	23%
	III	28.4	15.0	22%
	IV	16.1	7.0	18%
	Mean	22.7	8.5	17%
«no intervention»	V	5.4	8.0	61%
	VI	8.9	8.0	37%
	VII	10.6	5.0	19%
	VIII	9.5	11.0	48%
	Mean	8.6	8.0	41%

Mortality of adult chickens

Despite the mortality among hens and cocks seemed to be higher in *«no intervention»* flocks (Table VII) we can not conclude of any significance regarding the small number of adult birds present in the studied flocks.

TABLE VII. ADULT BIRD MORTALITY.

Groups/flocks		Hen mortality			Cock mortality		
		Mean of hens present a year	Number of dead birds	Mortality rate	Mean cocks present a year	Number of dead birds	Mortality rate
«intervention»	I	14.5	1	07%	3.0	1	33%
	II	8.1	0	00%	2.1	0	00%
	III	11.4	4	35%	5.6	0	00%
	IV	4.1	0	00%	1.5	0	00%
	Mean	9.5	1.3	10%	3.1	0.25	08%
«no intervention»	V	7.3	5	68%	1.0	0	00%
	VI	5.4	1	19%	2.2	0	00%
	VII	6.5	0	00%	1.0	0	00%
	VIII	4.0	2	50%	1.1	1	93%
	Mean	5.8	2.0	34%	1.3	0.25	23%

Egg production

Egg production in *«intervention»* and *«no intervention»* groups is depicted in Table IX. Mean number of total eggs produced in *«intervention»* group and *«no intervention»* group was 1767 and 807 eggs, respectively. Mean number of total eggs produced per hen present in the first category of birds (188 eggs/hen present) was significantly (P=0.01) higher than that in the second category of flocks (141 eggs/hen present).

Table VIII. GLOBAL EGG PRODUCTION.

Groups/flocks		Mean number of hens present	Total number of eggs produced	Mean number of eggs produced/hen
«intervention»	I	14.5	2753	190
	II	8.1	1445	178
	III	11.4	2014	177
	IV	4.1	854	208
	Mean	9.5	1767	188
«no intervention»	V	7.3	950	130
	VI	5.4	874	162
	VII	6.5	832	128
	VIII	4	574	144
	Mean	5.8	807	141

During the study period, the evolution of egg production expressed as mean of eggs produced per hen present and per week is represented in Fig. 4 and Table X. From September 2002, egg production has shown a continuous decrease until January 2003 in both *«intervention»* and *«no intervention»* flocks. This decrease was more significant in *«no intervention»* flocks (P=0.01). From February egg production started to increase to reach similar level in both categories of birds; 4.2 and 4.1 eggs in *«intervention»* and *«no intervention»* flocks, respectively. Then it has drastically decreased in all flocks coinciding with a chicken pox outbreak during April 2003 (35-37 weeks of study period; Fig. 5. before to increase again during the last months of the study period in both categories of flocks.

TABLE IX. THE EVOLUTION OF EGG PRODUCTION DURING THE WHOLE STUDY PERIOD. (JULY 2002JULY 2003)

Periods of survey	Weeks in period	Mean eggs produced/hen/week	«intervention» flocks	«no intervention» flocks
P1 :	31/7-04/09	5.0	5.1	3.7
P2 :	4/9-25/9	3.0	3.1	1.1
P3 :	25/9-16/9	3.0	1.9	0.7
P4 :	16/9-30/10	2.0	1.9	0.9
P5 :	30/10-8/11	1.3	2.3	0.7
P6 :	8/11-27/11	2.7	3.0	1.1
P7 :	27/11-11/12	2.0	3.5	1.5
P8 :	11/12-26/12	2.1	3.4	1.5
P9 :	26/12-8/1	1.9	3.4	1.9
P10 :	8/1-22/1	2.0	3.6	2.4
P11 :	22/1-5/2	2.0	3.7	2.8
P12 :	5/2-5/3	4.0	3.9	3.5
P13 :	5/3-18/3	1.9	4.2	4.1
P14 :	18/3-2/4	2.1	3.3	3.3
P15 :	2/4-16-4	2.0	2.4	2.3
P16 :	16-4-7/6	7.4	3.3	2.9
P17 :	7/6-17/6	1.4	5.0	4.5
P18 :	17/6-1/7	2.0	5.2	5.5
P19 :	1/7-15/7	2.0	5.5	5.4
P20 :	15/7-29/7	2.0	5.3	5.5

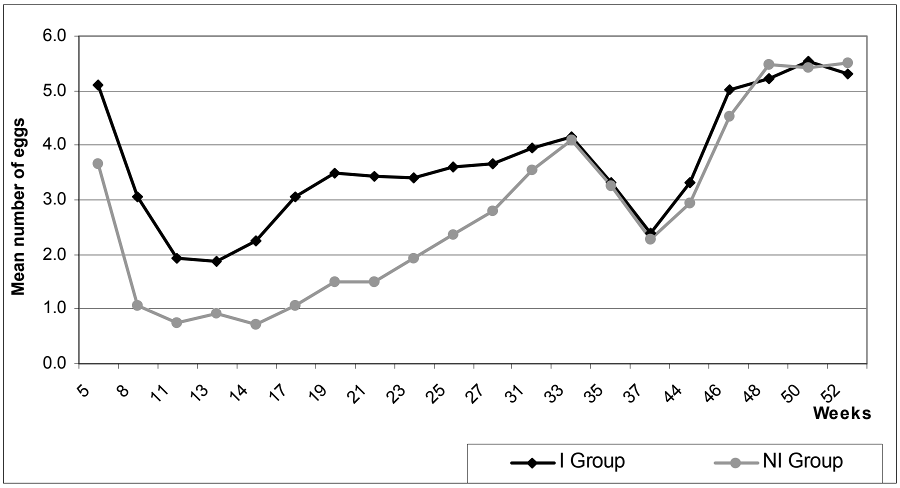

FIG. 4. The evolution of egg production from 31 July 2002 to 29 July 2003

FIG. 5. A hen with chicken pox lesions

Feed consumption

Feed was distributed to chicks *at libitum*. Adult chickens and cockerels/pullets in *«intervention»* flocks were given a feed supplement of 25 grams per bird/day which represents about 25% of the daily requirements of an adult bird (Anonymous, 1993). This feed supplementation was provided from September 2002 to Marsh 2003 and aimed to help filling the feed gap during this period (autumn and winter) of a low range feed availability in the study area.

Feed consumption in *«intervention»* flocks is represented in Table XI. The total feed distributed to birds varied from 93.7 to 279.3 kg for a value of 243.6 to 725.4 MDH (Moroccan Dirham, the local currency), respectively.

TABLE X. FEED CONSUMPTION IN *«INTERVENTION»* FLOCKS.

«intervention» group/flocks	Total feed consumed (kg) By chicks	By adult chickens and cockerels/pullets	total	Value MDH) (2.6 DH/kg)
I	66.2	213.1	279.3	725.4
II	36.7	87.2	123.9	322.1
III	64.5	117.6	182.1	473.5
IV	28.4	65.4	93.7	243.6

1 MDH = 0.1 US$

Cost benefit analysis

Parameters taken into account in the input included the value of the flock at the beginning of the experiment and the cost of feed. The cost of brooders and housing was not counted in the analysis, considering it as a long term investment. Medication (anti-parasitic treatment) was not considered also in the analysis because of its very low cost and vaccination was applied to both study groups. Those parameters counted in the output included the flock value at the end of experiment plus the value of consumed and sold birds and eggs (Table XII).

The value of profit in *«intervention»* flocks varied from 2470.00 to 6488.00 MDH with a mean value of 4710.00 MDH; whereas in *«no intervention»* flocks the profit did not exceed 1524.00 with a mean value of 1400.00 MDH. In order to make comparison between the 2 categories of flocks, the relative profit was expressed as the output/input ratio. *«intervention»* flocks made significant and better profit than *«no intervention»* ones ; the mean relative profit in *«intervention»* flocks was 3.64 and only 2.55 in *«no intervention»* flocks.

TABLE XI. INPUT, OUTPUT AND PROFIT IN TRIAL FLOCKS.

Groups/ flocks		INPUT			OUPUT				PROFIT	
		Value of flock at beginning	Value of feed	S/total (MDH)	Value of flock at end	Value of sold and consumed birds	Value of sold and consumed eggs	S/total (MDH)	Output: input ratio	Net profit (MDH)
«intervention»	I	2100.00	725.4	2825.40	1840	4720	2753	9313	3.30	6488
	II	980.00	322.1	1302.10	1870	1810	1445	5125	3.94	3823
	III	2220.00	473.5	2693.50	1580	5160	2014	8754	3.25	6061
	IV	560.00	243.6	803.60	1300	1120	854	3274	4.07	2470
	Mean	1465.00	441.15	1906.15	1647.5	3202.5	1766.5	6616.5	3.64	4710
«no intervention»	V	980.00	0.00	770.00	1140	200	950	2290	2.97	1520
	VI	980.00	0.00	980.00	720	910	874	2504	2.56	1524
	VII	1250.00	0.00	1250.00	690	1250	832	2772	2.22	1522
	VIII	740.00	0.00	740.00	580	830	574	1984	2.68	1244
	Mean	987.50	0.00	987.50	782.5	797.5	807.5	2387.5	2.55	1400

1 MDH = 0.1 US$

DISCUSSION

The results indicate that the performed interventions had an overall beneficial effects on the parameters studied. Flock size and structure and flock production was significantly improved in *«intervention»* flocks compared to *«no intervention»* ones. The observed mortality of young birds (Chicks and cockerels/pullets) in *«intervention»* flocks was significantly lower than in *«no intervention»* flocks. This may be directly related to the implementation of brooders and feeding of the chicks. Under normal production conditions, where mortality was found very high in young birds, the farmers were not used to supplement the chicks nor to provide brooders (Kichou *et al*., 2002b). It seems that this factors had tremendous positive effect on production since they had enormously contributed to the reduction of mortality and losses and consequently to the repopulation of flocks at a normal pace.

Since birds from both categories of flocks were vaccinated against NCD and Gumboro disease, the 2 most prevalent infectious disease in family poultry in Morocco (Bell, 1986, Mouloudi 1987, Kichou *et al*., 2002a), The causes of high morality in *«no intervention»* flocks would be underfeeding, other infectious diseases (Kichou *et al*., 2002b). Losses from predators would be another contributing factor to losses of chicks because of lack of brooders in these flocks.

During the whole study period the total egg production was significantly higher in *«intervention»* flocks. Furthermore, the decrease in egg production observed during the autumn and winter in both categories of flocks which is related to the short day light period, was significantly lesser in *«intervention»* flocks. This difference may be explained by the feed supplement we have assigned to birds from these flocks. Even the feed supplement represented only 25% of the daily requirements of hens, it contributed to fulfil the energetic needs of birds during that period of low range feed resources (Kichou *et al*., 2002b). It is not known how would be the egg production if a more important feed supplement have been provided taking into account that a such increase would raise the cost of production and consequently may lead to lower benefit margins.

A drastic decrease in egg production has concerned all flocks because of a severe chicken pox outbreak during April 2003. Just after the outbreak production has progressively returned to normal levels. Chicken pox outbreaks have been probably observed before in family poultry but this constitutes the first report of this disease in family chickens in Morocco.

The cost-benefit analysis has shown that *«intervention»* flocks have made better profit than *«no intervention»* flocks. The mean relative profit in *«intervention»* flocks was 3.64 and only 2.55 in *«no intervention»* flocks. Farmers from *«intervention»* flocks could improve their production by the implementation of interventions we have assigned. This was achieved with little charges, which helped to get beneficial results. This show clearly that the implementation of such interventions, with reasonable costs, by the farmers themselves at a larger scale would have a positive effects on the farmers income in particular and on family poultry production sector in general.

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IMPROVEMENT OF HEALTH AND MANAGEMENT OF VILLAGE POULTRY IN MOZAMBIQUE

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Abstract

Characteristics of the village poultry production are discussed, including constraints such as inadequate health care associated with Newcastle disease (ND) outbreaks as well as low productivity and inadequate housing. Once ND has been controlled, it will be essential to improve housing, nutrition and general management.

INTRODUCTION

Mozambique is located in South East Africa and covers an area of 802,000 km^2. In 1999, the population was estimated to be 16 million (52% female and 48% male) with 71% living in rural areas [1]. Two thirds of Mozambicans live in absolute poverty, surviving on less than a quarter of US dollar per day. It is estimated that 72% of the general population is illiterate. Illiteracy is higher among women (85%) [2]. Mozambican economic development is based on agriculture with livestock and crop production considered to be the cornerstone of poverty alleviation. Recognising the potential value of livestock, including rural poultry production, to household food security, income generation and poverty alleviation, the improvement of smallholder poultry production has became a priority within the National Agriculture Development Programme.

The control of Newcastle disease in village chickens in Mozambique has been intensively studied since the mid-1990`s by the National Veterinary Research Institute (INIVE) [3]. The studies involved three types of ND vaccine: ITA-NEW, NDV4-HR and I-2 [3]. INIVE continues to produce the I-2 ND vaccine for use in rural areas.

MAIN CHARACTERISTICS OF VILLAGE POULTRY PRODUCTION

Village poultry production in Mozambique is based on scavenging indigenous domestic fowl. Small-scale farmers own over 90% of the national flock, which is estimated to be approximately 25 million birds. The “local” chicken raised by village farmers is characterized by a great variety of types and colours and low production, but it is well adapted to the environment and resistant to many common diseases.

Production ang reproduction

The average weight at slaughter (at 5–6 months) is 1.3 kg. Hens lay from 40 to 50 eggs per year in 3 to 4 clutches, with almost all eggs being destined for incubation. The flock size per household is about 7 to 15 birds. The first incubation is observed at 9-12 months of age, with 10-12 eggs per clutch; 8-9 chicks are hatched (78% hatching rate) and survival rate is low ranging from 6–7 live chicks (66–69%) [4, 5]. From July to December hatching is reduced and chick mortality is higher. Lower chick mortality occurs when maize plants are high and birds can hide from predators (February-June). Low hatching rates in the summer seasons are mainly due to poor nest types and external parasites [4].

Housing

Around 47% of households do not provide a house or shelter for their birds usually the birds perch in trees or stay on roof of owners house [4, 5]. Approximately 5% of the households keep birds inside the main house and 48% of households provide a chicken house for the birds.

The most common chicken house is usually made from locally available materials such as wood, bamboo and mud bricks. In areas where poor housing is common, losses due to predation are high. Some farmers are afraid to build a chicken house because they believe that it will be easier for the thieves to steal the birds.

Nutrition

Generally, village poultry farmers are poor and cannot afford to purchase commercial feeds for their birds. Thus, almost all of the feed for the birds comes from the local environment. The feed supply is relatively stable when the environment can provide an abundance of food and water during the rainy season. However, this situation deteriorates with the advent of the dry season. Often by the end of the dry period, neither scavenged food nor household refuse and crop by-products are sufficient to maintain a satisfactory level of production [4, 5].

Predation

Besides the loss of birds due to disease the major source of loss of live birds are the activities of thieves and predators [5]. Predators can be classified into two groups: one consists of birds of prey, which tend to take young chickens; and the other group are mammals such as cats, dogs and wild animals that attack both adults and young birds.

DISEASES OF VILLAGE POULTRY

The main problem in village chicken production is Newcastle disease (ND) with farmers complaining annually of high mortality in their chickens. ND has been described by several authors as a major constraint to development of poultry production in rural areas [6, 7, 8].

Newcastle disease

ND is endemic in the country, occurring every year mainly in village poultry. Although few surveys of prevalence of ND in Mozambique have been undertaken, available information indicates that this disease is the most important constraint to the rearing of rural chicken [6, 7, 9]. In 1955 INIVE commenced production of attenuated, live ND vaccines and produced vaccines based on strains F, B1, La Sota and Komarov [10]. In 1996, the Australian Centre for International Agricultural Research Project assisted with the introduction of I-2 ND vaccine. This thermotolerant ND vaccine was successfully tested and a comprehensive ND control package based on this vaccine developed for use in rural areas. The I-2 ND vaccine is now in use in five provinces with vaccination being performed by community vaccinators on a cost-recovery basis.

In 2000, World Vision Mozambique with funding from the Australian Agency for International Development, initiated a food security project in Manjacaze district, Gaza province, with a ND control component using I-2 ND vaccine. Around 25,400 chickens were vaccinated in this period representing 87% of participating poultry farmers [11]. Sera from both vaccinated and unvaccinated chicken were collected and tested using the HI test. Results showed that 90.5% of vaccinated chicken had an average geometric mean titre (GMT) of $\log_2$ 6 and 36.8% of unvaccinated chickens had a GMT of $\log_2$ 3.5.

Other diseases in rural poultry

Survey data on other diseases affecting village poultry production are scarce. The information collected at farm level by surveys showed that after controlling ND, other diseases such as fowl pox, and endo- and ecto-parasites may play a role in chicken mortality [9].

CONCLUSION

To improve the village chicken production in Mozambique, strategies include reduction of the losses caused by ND through vaccination of village chickens and improving their productivity through better nutrition, housing and general management.

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INCREASING FAMILY POULTRY PRODUCTION IN THE SUDAN THROUGH NEWCASTLE DISEASE CONTROL AND IMPROVING HOUSING

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Abstract

This report describes field experiences in the improving family poultry production in the Sudan. Activities associated with investigation of features of production and constraints to this sector are reviewed. Constraints include inadequate health care associated with attacks of ND as well as external and internal parasites, poor productivity and inadequate housing. Interventions implemented included control of Newcastle disease by a wet thermo stable vaccine produced locally and improving housing by the supply of chicken cages. The interventions resulted in a substantial increase in egg and meat production that contributed positively to increasing household food security and the generation of supplementary cash income. Future implementation of the findings of this research project necessitates considerable community and governmental participation.

INTRODUCTION

Throughout Africa, village chickens are the chief source of animal protein in rural areas [1, 7]. In addition, they were reported to have a great social importance [5]. Among a population of 45.3 millions of chicken in Sudan, the conventional sector contains around 30 millions (66.2%) from which the annual meat and egg production is about 20.1 million birds and 900 million eggs respectively [6].

In 1999 the Animal Production and Health Section of the Joint FAO/IAEA Division embarked on a programme to promote farmyard poultry production in Africa by developing practical vaccination strategies against ND and Gumboro disease in some African countries and monitoring immunity using ELISA technique. The present communication is an overview of activities of the project in the Sudan.

MAIN FEATURES OF VILLAGE POULTRY PRODUCTION

The production system in rural areas of the Sudan is based on scavenging indigenous domestic fowl. Flock size in this system averages 18.3 birds per household and varied between 6 and 63 birds. The average clutches recorded per hen per year were 3.1 and ranged from 1 to 6. Average eggs per clutch were 12 and varied between 2 and 20. Chick mortality (chicks died / chicks hatched) was 22.4%.

Housing status in villages

In response to question on where chickens roost, round half (48.7%) of households stated that they provide chicken house for their birds to stay overnight. For 20.6% of households no house or shelter was provided and chickens roost overnight in the main house while some birds (12.8%) perched in trees or stayed overnight on a roof. The most common types of housing observed in the study area were made from locally available materials such as mud, wood, bricks and sometimes scrap metals. Poor housing facilities observed in the study area highlighted the need for a better housing as a strategy to reduce losses, particularly from predators. Although there were some types of housing, this was generally inadequate and farmers themselves requested an effective and affordable housing design.

Animal health status

We recorded that about 77% of surveyed households experienced disease problem during the year that precede commencement of the project [4]. External parasites (ticks and mites) and Newcastle disease are the most important and prevailing diseases in the study areas with 50% and 30% incidence rate respectively. Other minor ailments include diarrhoea, swollen joints and jaundice.

CONSTRAINTS TO POULTRY PRODUCTION

The major constraints encountered during the surveys of village poultry production in the Sudan were identified by our team as inadequate health care associated with attacks of ND as well as external and internal parasites, poor productivity and inadequate housing.

Diseases of village poultry

Newcastle disease

Newcastle disease virus (NDV) was first isolated and identified in the Sudan in 1962 in a natural outbreak of the disease [2] and the most prevalent strains of the virus identified were reported to belong to the viscerotropic velogenic pathotype [3]. During the first year of this project and before implementation of interventions, two out of 20 households (10%) in zone 1 reported occurrence of ND during the study year compared to nine out of 12 households (75%) in zone 2. The disease caused an overall mortality rate of 76% with a mean mortality rate of 66% and 69% in zone 1 and 2, respectively (Table I). All age groups were found affected and the mortality rate was 70% in chicks, 98% in growers and 62% in adults (data not shown).

Two isolates of NDV were obtained in embryonated eggs following their confirmation by HA and HI using a reference NDV serum. The isolates were designated as GD.S.1 and GD. Gh.1. The isolates showed similarity in that they kill embryos rapidly in mean death time test, produced visceral lesions in 8-week-old chicks and had a high intracerebral pathogenicity index (ICPI). Accordingly, the isolated viruses were grouped as velogenic viscerotropic NDV (VVNDV) pathotype.

Early in this project a serological survey was conducted for antibodies against ND in village chickens measured by ELISA. The sero- conversion and presence of antibody against ND, indicate previous exposure to the virus. It was noted that the antibody prevalence in village chickens in zone 2 (Gadarif area) was higher compared to zone 1 (Khartoum area).

External parasites

External parasites (ticks, mites and lice) are considered the most prevailing diseases in the study area with 50% incidence rate. Ticks (*Argus persicus*) in severe infestations can lead to paralysis and death. External parasites are a major problem which can proliferate under the current poor housing conditions observed in the study area. Materials commonly used to build poultry houses in the study area trigger external parasites and prevent their control. During the first two years of this study we detected tick infestation in 7 out of 22 households in zone 1 (32%) and 10 out of 12 households (83%) in zone 2. Red lice were detected only in 5 households in zone 2.

Internal parasites

Cestodes and trematodes are common in village chickens because the husbandry practices favour the intermediate hosts (ants, beetles, earth worms, etc.). Table III lists helminth parasites detected as oosysts in fecal samples collected during 2001-2003 in the study area with their prevalence rate. The incidence of tape worms was higher in Zone 2 compared to Zone 1 probably due to climatic conditions of heavy rains that facilitate growth of the vectors.

TABLE I. DETAILS OF NEWCASTLE DISEASE OUTBREAKS DURING JULY-AUGUST 1999.

ZONE NO.	VILLAGE NO.	HOUSEHOLD NO.	NO. DEAD/TOTAL NO. OF AFFECTED CHICKENS (%)
1	5	2	10/18 (56)
1	5	4	4/10 (40)
2	1	1	25/26 (96)
2	1	2	45/54 (85)
2	1	3	18/23 (78)
2	1	4	20/23 (91)
2	2	2	11/12 (92)
2	2	3	41/50 (82)
2	3	1	21/34 (62)
2	3	2	14/23 (61)
2	3	4	12/21 (57)
TOTAL	11		222/294 (76)

TABLE II. ANTIBODY AGAINST NDV AS DETECTED BY ELISA IN VILLAGE CHICKENS IN THE SUDAN IN 2000.

ZONE NO.	VILLAGE NO.	NO. POSITIVE/ TOTAL NO. TESTED (%)
1	1	2/35 (5.7)
1	2	3/39 (10.2)
1	3	5/43 (2.3)
1	4	0/33 (0)
1	5	9/54 (17)
2	1	9/28 (32.1)
2	2	14/24 (58)
2	3	12/29 (41)
TOTAL		55/310 (18)

TABLE III. INFESTATION OF INTERNAL PARASITES IN VILLAGE CHICKENS IN THE SUDAN.

PARASITE	FECAL INFESTATION RATE	
	ZONE1	ZONE 2
Raillietina spp.	20 %	41%
Choanotaenia	2.9 %	12%
Subulura spp.	5.7 %	30%
Cotugenia spp.	-	4%
Ascaridia spp.	2.9 %	55%
Gongylonema spp.	-	4%
Acuaria spp	-	2%
Coccidia spp.	10 %	33%

Bacterial infections

During the course of this project *E.Coli* and *Salmonella spp* were isolated from several village birds brought to the laboratory. In one occasion a mortality of 20% due to septicaemia caused by Salmonella was reported.

Gumboro disease

To date no diagnosis of IBD in village poultry of the study area has been made. A serological survey using agar gel diffusion test (AGDT) for antibodies to IBD revealed a prevalence of 5% and 28% for zone 1 and 2, respectively (Table IV).

TABLE IV. PREVALENCE OF ANTIBODIES AGAINST INFECTIOUS BURSAL DISEASE IN VILLAGE CHICKENS IN THE SUDAN.

ZONE	VILLAGE	NO. OF POSITIVE SERA/ NO.TESTED SERA (%)	TOTAL ZONE PERCENT POSITIVITY
1	EL Daba	1/25 (4%)	
1	Ezergab	1/18 (5.6%)	
1	El Gaili	2/36 (5.6)	5%
1	Hassana	1/17(5.9%)	
1	Abohalima	1/24 (4%)	
2	Abbayo	5/22(22.7%)	
2	Elsofi	7/28(25%)	28%
2	Ghibaisha	10/27 (37%)	

INTERVENTIONS

Vaccinating against ND

During the period 1999-2003 more than 6000 doses of ND I_2 vaccine were distributed to households in both zones. The vaccine was divided into aliquots of 0.5 ml each and kept at–20 ^{0}C in two main distribution points each for one zone. The method used to administer the vaccine was intraocular route with a dose of 2X 10^6 EID $_{50\%.}$ Initially vaccination was performed by veterinary assistants and subsequently by the farmers themselves after adequate training.

Control of other diseases

In the earliest field visits chickens infested with ticks or lice were dipped in an insecticide solution and the farmers were trained how to properly dilute the insecticide and use it safely. In some instances antibiotic powders were distributed in case of complaints attributed to bacterial infections and also de-wormers.

Improvement of housing

Chicken cages in a rectangular shape and of dimension 2X1X1 meter were constructed. The cages were made of metal bars and were fitted with wire net on all sides and over the top. The cages are light in weight and movable. A metal door was built on the small side of the cage to enable entry and release of chickens. The average cost of a cage was estimated at 29 USD. Twenty chicken cages were locally manufactured and distributed to 12 households in zone 1 and 8 households in zone 1. The remaining households of the project were left as control.

OUTCOMES OF INTERVENTIONS

To assess the impact of the interventions introduced (control of ND and supply of chicken cages) we propose to use a combination of two approaches: epidemiological and economic.

Control of Newcastle disease and other diseases

Epidemiology

If we look at the incidence of ND outbreaks recorded in the year 1998/1999 before commencement of vaccination and during 3 years after vaccination (Table V) a clear pattern of decline in the incidence is obvious. Two outbreaks were recorded in region 3 of zone 1 due to cessation of vaccination during the rainy season caused by the absence of the assigned veterinary assistant.

TABLE V. NUMBERS OF NEWCASTLE DISEASE OUTBREAKS PRE- AND POST-VACCINATION.

	NO. OF OUTBREAKS	
	PRE-VACCINATION	POST-VACCINATION
ZONE 1	2	0
ZONE 2	9	2

With regard to external and internal parasites and bacterial infections, though no accurate measurements on their effect were made, there is a marked improvement in the health of chickens in the study area and the complaints from such ailments declined substantially.

Economy

As a result of ND vaccination, the increase in total number of chickens is translated into an increase in their sale and consumption. Since improving housing also contribute to the economic analysis of costs and benefits the whole calculation will be described later.

Usefulness of chicken houses

Farmers who received chicken cages were visited frequently to assess the use of the cages. All households except 2, all from zone 1, utilized the cages but with different usages (Table VI). Those farmers who prefer to use the cages for rearing newly hatched chicks separately explained that by this way they reduce chick losses and eventually increase the output of eggs and meat. It is known that lack of proper shelter for chicks immediately after hatching results in high mortality. Further more this practice according to the farmers increased their profit and subsequently encouraged them to buy additional chicks and rear them together with their own. We noted that two of these farmers succeeded in building new cages using the same specifications.

Those who prefer using the cage for brooding argue that brooding chickens and their newly hatched chicks become secure from predators while been kept in the cage.

It is noteworthy to mention that 8 out 18 households recorded that they started given feed supplements to their chickens after the use of the cages.

Criticism to the use of chicken cages include the small size of cages and possible generation of heat during summer times. In one occasion the farmer who received the cage claimed that it is useless and she is no longer use it.

TABLE VI. USAGE OF CHICKEN CAGES IN VILLAGE IN THE SUDAN.

NO USE	FOR ADULTS	FOR BROODING	FOR CHICK REARING	MIXED USE
2	7	3	5	3

ECONOMIC ANALYSES

Accounting for inputs

Newcastle disease vaccine production costs

- Production of 8000 doses of I-2 vaccine costs 800 Sudanese Dinnars (1 USD=260 Dinnars); so one dose costs 0.0004 USD. However for the sake of sustainability we calculated the cost according to the cost of a commercially available vaccine (Komarov strain locally produced in the Central Veterinary laboratory). This vaccine costs 0.023 USD per dose. The cost of vaccinating 1000 chickens per year would equal to 23 USD.
- A number of 20 chicken cages of dimension 2x1x1 meter were constructed. The cost of materials and labor to make one cage is 29 USD which is equal to the value of 19 adult village chickens.
- Selling price of adults:1.8 USD; lowered in the 2nd year to 1.7
- Selling price of growers:0.8 USD lowered in the 2nd year to 0.7
- Selling price for eggs:0.112 USD per an egg ; increased to 0.123 in the 3rd year.

Budgeting

Income calculations and determination of profit and return for years 1, 2 and 3 of the project are presented in Table VII.

TABLE VII. SUDAN PARTIAL BUDGET.

US Dollars	Year 1: Vaccination + antibiotics and insecticides	Year 2: Vaccination + antibiotics, insecticides and cages	Year 3: Vaccination + antibiotics, insecticides and cages
INCREASE IN INCOME	763.00	2,315.00	2,315.00
Increased cost	121.00	705.00	125.00
Vaccination cost	23.00	30.00	30.00
Housing cost	0.00	580.00	0.00
Labor cost	38.00	45.00	45.00
Antibiotics and insecticides cost	60.00	50.00	50.00
Profit	642.00	1,610	2,190
Return	6.3	3.3	18.5

It can be seen that the gross profit margin of poultry production in the participating households have increased remarkably and the interventions we introduced are feasible. However, we believe that the most useful indicator to draw farmer's attention is what they actually gained. The answer we received from the farmer, who do not care of costs and benefits calculation, in most cases, was that we are now living better than before.

CONCLUSIONS

In the present report we described the feature of village poultry production in the Sudan and how we tried to improve it through interventions consisted of disease control and improve housing. The interventions resulted in a substantial increase in egg and meat production that contributed positively to increasing household food security and the generation of supplementary cash income. For sustainability and implementation of results of this project considerable community and governmental participation is needed. The results would form a basis for designing a package of disease control and improving housing and sets guidelines for increasing family poultry production. The funds transferred through the project were invaluable and allowed us to improve our research capacity and initiate applied research for the benefit of our community.

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OBSERVATIONS ON PRODUCTION, LABORATORY TESTING AND FIELD APPLICATION OF I-2 THERMO STABLE NEWCASTLE DISEASE VACCINE IN THE SUDAN

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Abstract

In the present study, a working seed of the Newcastle disease (ND) thermostable vaccine (I-2) vaccine (supplied by ACIAR, Australia) was prepared in Sudan (CVRL, Khartoum). Experimental trials were conducted to determine safety, potency and the effect of age of chickens, route of administration and dose on the immunogenicity of the vaccine. Vaccination of chicks at 2 and 3 weeks old yielded better immune response and higher protection rates as compared to 1 day and 1 week. Boostering of chicks resulted in a relatively better ($p< 0.05$) immune response in all age groups as compared to those vaccinated once. With regard to dose, total protection against challenge infection was attained when chicks were vaccinated with double the recommended dose of the vaccine via the intraocular route (I/O). The I/O route was found to be superior to the intranasal (I/N) which was confirmed to be better than the drinking water (D/W) route as observed from antibody titers and percent protection after challenge. Comparison of the doses involved using half, recommended, double and four times the dose of the I-2 vaccine, proved that even half the dose resulted in a reasonable immune response and protection. Moreover, using double or even four times the dose gave 100% protection without resulting in any adverse post vaccinal reactions. Field vaccination trials of village chickens (Baladi) by the D/W, I/O and I/N routes using I-2 vaccine showed better immune response for I/O route as compared to other routes. The immune response was superior when the I-2 vaccine was used as compared to Komarov vaccine. Use of the thermostable vaccine of ND (I-2) was proved- from results of this work- very reliable, as it was safe, highly immunogenic and protective. Experiences in distribution of the vaccine and vaccination of village chickens are discussed.

INTRODUCTION

Newcastle disease (ND) is a contagious and fatal viral disease affecting all species of domestic and wild birds. It was also defined as one of the most important diseases of poultry worldwide [17]. The disease is caused by a virus belonging to the genus *Rubulavirus* of the subfamily *Paramyxovirinae* of the family *Paramyxoviridae* [17].

Newcastle disease is a major health problem in poultry industry with a worldwide distribution. The modes of the disease transmission are correlated with the routes of the vaccine application. Transmission of Newcastle disease virus (NDV) between birds is by either inhalation or ingestion. It is clear that infective virus may be present in aerosols and that birds placed in an atmosphere containing such aerosols become infected [2]. This is the basis for application of live vaccines by spray and aerosol generators [16]. Ingestion of contaminated faeces is also proved as the main method for bird to bird spread of virulent enteric (NDV). Similarly, this assumed the application of the vaccines via the drinking water and food [3].

The most common routes of ND live lentogenic vaccines application, used worldwide, are via the drinking water (D/W), intranasal (I/N), eye dropping (I/O) and beak dipping (B/D) [2]. Application of live vaccines by sprays and aerosols is popular due to the ease with which large numbers of birds can be vaccinated in a short time [2].

Other routes of vaccine application such as wing-web (W/W) and intramuscular (I/M) injection are exclusively adopted for the mesogenic strain vaccines as they tend to display greater virulence for birds. Examples of these are Mukteswar, K and Roakin. mesogenic vaccines [2].

The thermostable vaccines of ND I-2 and V4 (Australian strains) are used to control ND in village flocks in Africa and Asia. According to Spradbrow [19], the best way of controlling ND in small family flocks in Asian countries was to administer the thermostable live vaccine strains orally. However, in some African countries these strains offered the best and most reliable protection at population level by eye drop method [1, 8].

As the live viral vaccines requires a cold chain during transport, thermostable vaccines, which tolerate high temperatures for longer than conventional vaccines, offered an opportunity to improve ND vaccination strategies for village poultry in Asia and Africa [13, 15].

In this study the effects of age, route of application and dose of ND thermostable vaccine (I-2) are determined experimentally and under Sudan field conditions. Information on efficacy outlined in the present work are needed prior to approval of this strain as a routine vaccine for village chickens.

MATERIALS AND METHODS

Viruses

The viruses used in the study were as follows: Freeze-dried I-2 seed vaccine of NDV, kindly supplied by Prof. P.B. Spradbrow from University of Queensland in Australia. The virus was originally isolated in Australia with funding from the Australian Centre for International Agricultural Research (ACIAR). A virulent velogenic viscerotropic NDV isolated from an outbreak of ND in El-Obeid (Sudan) was used in this study as a challenge virus. LaSota strain was used for preparation of the antigen used in HA and HI tests.

Chicken embryonated eggs

Embryonated eggs and one-day-old chicks were obtained from the poultry farm of Coral Poultry Company in Khartoum. Chicks were vaccinated against infectious bursal disease (IBD) at two-weeks of age.

Blood sampling

Chicks used in vaccination trials were sampled for blood by heart puncture using disposable syringes and then the sera separated.

Haemagglutination (HA) and haemagglutination inhibition (HI) test

These were done as described by Allan et al [7].

Preparation of I-2 wet vaccine

One ampoule of freeze-dried I-2 seed strain of NDV was diluted with 20mL sterile phosphate buffered saline (PBS) and divided into ten vials, each of which contained two mL and stored as master seed at –20°C.

Two vials of the master seed were thoroughly mixed and used to inoculate 40 embryonated eggs by the allantoic route with a dose of 0.1mL/ egg. Each egg was harvested separately and the allantoic fluids (AFs) were tested by the HA and HI tests for the virus identification. Positive AFs were then pooled and centrifuged at 2000 rpm for 30 minutes and dispensed in 2mL cryogenic vials and stored at –20°C prior to use as a working seed. Vaccine batches were prepared from the working seed in embryonated eggs.

Titration of the vaccine virus

Titration of virus infectivity was done following standard techniques [21].

Sterility test of the vaccine

Samples were taken with a Pasteur pipette from a reconstituted vial of vaccine and cultured on thioglycolate media, mycoplasma broth and sabouraud broth.

Challenge infection

Vaccinated and control chicks that were used in laboratory vaccination trials were challenged with the virulent Sudanese isolate of NDV El Obeid strain). All chickens were challenged with 0.2 mL of the virus containing 2x $10^{8.2}$/0.1mL EID_{50} using intramuscular (I/M) route. Challenged chickens were observed daily for a period of 14 days after the challenge the mortalities were recorded.

Experimental design

One hundred, one-day old chicks were divided into five groups of 20 birds each and vaccinated at one day-old, 1,2 and 3 weeks of age with 0.1 mL of I-2 vaccine containing $10^{6.13}$ EID_{50} intranasally. Vaccinated chicks were further divided into two subgroups of 10 chicks each (a & b). Chicks in the subgroup (a) were not boostered while chicks in the subgroup (b) received a booster dose of the same vaccine 2 weeks post first vaccination. All five groups including the control were challenged four weeks (booster dosed group) and six weeks (single dosed group) post last vaccination. The antibody response to the vaccine was assessed by the HI four and six weeks after the first and second vaccination and after challenge.

To determine the effect of route of administration on the immunity to the vaccine, forty chicks were divided into groups) of ten chicks each and were vaccinated at two weeks by I/N, I/O and DW routes. Two weeks later, vaccinated chicks boostered via the same routes of first vaccination. Four weeks later, all chicks including those in the control group were challenged with the virulent NDV.

To determine the effect of the vaccine dose on immunity, fifty chicks were divided into five groups) of ten chicks each and vaccinated via the I/N route with recommended dose, half dose, two times and four times recommended dose of the vaccine. Humoral immune response was measured by HI and protection by challenge experiments with the virulent NDV.

Field vaccination trial

This experiment was conducted to determine the immunogenicity of the thermo stable I-2 vaccine of NDV under Sudan field conditions and consisted of two field trials: (*i*) Three flocks of commercial layers were vaccinated at three-week-old with I-2 vaccine using the I/O route. Another three flocks were vaccinated with K-strain at the same age with the recommended dose using I/N route. (*ii*) Five flocks of adult indigenous village chickens were vaccinated by I-2 and K-strain as for the commercial layer flocks.

Field application of I-2 vaccine

Based on the results of previous experiments we started to vaccinate village chickens in both zones using the I/O route of administration and double recommended dose of the vaccine (10^6 EID_{50} / dose). Two distribution points (Faculty of Veterinary Medicine, Shambat for zone 1 and The Regional Veterinary Laboratory, Gedarif for zone 2) were supplied with aliquots of the vaccine (0.5 mL vials) which were kept at –20 °C. Only healthy chickens were vaccinated and farmers were informed of the need to revaccinate their chicks. Veterinary assistants representing each participating village were trained how to keep the vaccine in good condition and how to dilute and administer it properly. Each assistant was instructed to perform vaccination or supervise vaccination by villagers in his village at intervals of 3-4 months. Eye droppers were distributed by our team after calibration according to the size of the drop that forms.

Statistical analysis

The statistical significance of differences between groups of data was determined using the two-tailed Student's unpaired t-test.

RESULTS

The master and working seeds of the I-2 vaccine and a batch of the vaccine were prepared. The 50% infectivity in embryonated eggs (EID_{50}) of the vaccine was estimated and found to be $10^{9.13}$/ mL the same as indicated in the manufacturer guideline for the vaccine production. The prepared vaccine was confirmed to be free from bacterial, mycoplasmal or fungal contamination.

The mean HI titres (log_2) and percent protection among the four age groups, before vaccination and six weeks after it and % protection two weeks post challenge when one dose of the I-2 vaccine was given are shown in Table I.

The mean HI antibody titers and percent protection produced by vaccination of two week-old chicks with ND-I-2 vaccine through I/O, I/N and D/W using half, recommended, double and four times the vaccine dose were demonstrated in Table II.

Intraocular route gave significantly ($p < 0.01$) higher antibody responses as compared to DW and slightly better than I/N route. The mean HI titers and percent protection produced were 5 log_2, 100% (I/O); 4.7 log_2, 90% (I/N) and 3.8 log_2, 45.5% (D/W). The immunity and protection obtained from the field trials were demonstrated in Table III.

TABLE I. THE IMMUNE RESPONSE (HI ANTIBODY) AND PERCENT PROTECTION OF CHICKENS VACCINATED AT DIFFERENT AGES WITH A SINGLE DOSE OF I-2 THERMOSTABLE VACCINE BY THE I/N ROUTE.

Age at vaccination	Mean titer (log_2)			Percent Protection (%) one month post challenge	
	Day pre-vaccination	6 week post vaccination Vaccinated chickens	Unvaccinated chickens	Vaccinated chickens	Unvaccinated chickens
One-day	5	3.9	1	50	0
One-week	4	4.1	1.6	60	0
Two-weeks	2.4	4.5	1.2	82	0
Three-weeks	1.4	4.6	0	82	0

TABLE II. EFFICACY OF I-2 VACCINE AGAINST ND GIVEN BY I/O OR I/N ROUTES AND DIFFERENT DOSES.

Route of vaccination and dose	Mean HI antibody titer (log_2)		Percentage Protection after challenge
	After vaccination	After boostering	
I/O 1/2 dose	4	5	95
I/O normal dose	5.5	6	100
I/O 2X dose	7	7.8	100
I/N 1/2 dose	4	4.5	87
I/N normal dose	4.5	5	90
I/N 2X dose	4.5	5.5	100
D/W normal dose	3	3.5	46

TABLE III. COMPARISON IN VILLAGE CHICKENS OF ND-VACCINES GIVEN BY DIFFERENT ROUTES.

Vaccine strain	***Route***	Mean of HI antibody titer before vaccination (log_2)	Mean of HI antibody titer after vaccination (log_2)
I 2	1/O	0.25	6
I 2	1/N	0.5	5
I 2	D/W	0.33	3.7
Komarov	1/N	0.33	5.5
Komarov	D/W	0.4	3.5

D/W: Drinking water
I/ N: Intranasal
I/ O: Intraocular

DISCUSSION

In the present study, the I-2 thermostable vaccine of ND supplied by ACIAR (Australia) as a master seed was tested under Sudanese conditions. The master and working seeds of the vaccine virus were prepared. The 50% infectivity in embryonated eggs (EID_{50}) of the vaccine was estimated and found to be $10^{9.13}$/mL the same as indicated in the manufacturer guideline for the vaccine production. The prepared vaccine was confirmed to be free from bacterial, mycoplasmal and fungal contamination. Experimental trials to determine the effect of age of chickens on the protective efficacy of the vaccine were conducted.

In this study, chicks vaccinated with the I-2 NDV thermostable vaccine administered intanasally at one and seven days of age gave low HI antibody titres and protection after challenge as compared to the older birds. There was a clear decrease in the mean antibody level after vaccination of one-day-old chicks while slight increase ($p < 0.05$) was noticed among the one week old birds, which was considered as insignificant. This indicates that even moderate levels of maternally-derived antibodies (MDA) interfered with the immune response to achieve vaccination at early life. These findings are clearly substantiated and in agreement of the previously mentioned data. However, boostering of these chicks two weeks after initial vaccination resulted in a slight increase ($p < 0.05$) in the HI titre with moderate protection levels after challenge.

Vaccination of young chickens which have high levels of maternally derived antibody (MDA) was previously considered as one of the main problems associated with control of ND in many parts of the world [6, 10]. However, other researchers proved that passive immunity does not necessarily interfere appreciably with a vaccine applied by the nasal or ocular instillation and they recommend these routes for vaccinating young chicks having maternal immunity [9].

Initial vaccination of chicks at the ages of two and three weeks resulted in relatively comparable and better results. This might be attributed to the gradual reduction of MDA (as shown in Table I) and also the progress of the immunological competence with age. As initial vaccination is required at an early age as much as possible in ND endemic areas and where the virulent type of the virus is prevalent, we assigned two weeks of age as the most reliable one during the course of these experiments. This was emphasized by the fact that the percent protection after challenge of the control groups was zero throughout the experimental trials.

In this investigation in on hand, better results were obtained when chicks were vaccinated via I/O route, resulting in high antibodies and good protection. This agreed with the findings of vaccination trials conducted in other African countries, using the same or other thermostable vaccines of ND, such as in Tanzania [11], Mozambique [1] and Zimbabwe [8]. On the other hand, chicks vaccinated through the I/N route showed inferior immune responses and protection rates as compared to I/O but superior to D/W route. Similar findings were previously reported by KHEIR [14] and GAFFAR ELAMIN *et al* [12].

Based on these findings, the I/O route is recommended for the vaccine application especially when smaller flocks such as breeder replacement flocks and village backyard chickens have to be vaccinated. Following the virus administration into the bird conjunctiva, it reaches the upper respiratory tract through the naso-lacrymal duct where it multiplies to induce the required immune responses. However, it may be impractical to use the I/O route in commercial poultry units that have large numbers of broilers to be immunized all at once. These units can consider mass vaccination methods such as D/W and spraying even though they result in a somewhat reduced immune response. This reduction response may occur using the D/W route because virus viability will be lost at the gastrointestinal tract (GIT), unless high amount of NDV ($> 10^5$ EID_{50}) is contained in the vaccine [20].

The effectiveness of different doses of ND-I-2 vaccine was also investigated during the present study. The results obtained revealed that at least double the recommended dose of the vaccine is required to offer total protection of chicks against challenge infection.

Moreover, the vaccine was proved to be absolutely safe since double or four times the recommended dose resulted in no adverse vaccination reactions among vaccinated chicks which looked normal and healthy throughout the experimental course. Allan [5] reported that an effective immune response is dependent on the presence, in the bird, of an amount equivalent to $10^{9.5}$ EID_{50} infective particles.

Usually mesogenic strains of NDV are used as booster vaccines because the mild live vaccines (those containing the lentogenic strains) do not multiply very efficiently when used as boosters in face of pre-existing immunity and hence secondary response that they induce is rarely very much higher than the primary response. This can be achieved by use of the more invasive live (intermediate) vaccines [22]. This observation was valid during the experiments of this study where boosting resulted in little increase ($p< 0.01$) in HI titres when the I-2 was used for repeated vaccination. Similar observations were reported by RAJESWAR AND MASILLAMONY [18] for LaSota and B1 and by ALI [4] for K vaccine.

Application of vaccination against ND using a wet vaccine prepared from I-2 strain in village chickens in the Sudan during the period 1999-2003 markedly decreased outbreaks of the disease in both zones and subsequently improved village chicken production. The epidemiologic picture of ND in the study area and benefits to villagers after implementing vaccination will be published in a separate article.

CONCLUSIONS

Our experience with production, distribution and application of I-2 vaccine has shown that it is feasible to produce and distribute the vaccine in regional basis. Storage of the vaccine at –20 °C in small aliquots provides constant supply suitable for the individual small flocks and reduces the cost. Application of these results targeting improving food security and generation of supplementary cash income require cooperation between research institutions, government authorities and rural farmers. One additional benefit relies in the fact that control of ND in village chickens will subsequently result in reducing infections in the growing commercial sector.

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THE PERFORMANCE OF VILLAGE CHICKENS IN SELECTED RURAL AREAS OF UGANDA, GIVEN NEWCASTLE DISEASE I-2 THERMOSTABLE VACCINE, LEVAMISOLE® TREATMENT AND FEED SUPPLEMENTATION.

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Abstract

Poultry health and management interventions for Newcastle disease, endo-parasite control and feed supplementation were introduced to a free-range poultry production system in six villages in two Agro-ecological zones of Uganda to improve chicken productivity. Newcastle disease vaccination using a locally produced I-2 thermostable vaccine of Embryo-infective dose (EID_{50}) of 10^8 per ml and LaSota cold chain vaccine of Embryo infective dose (EID_{50}) of 10^9 ml, one for each zone, where given to chickens by the eye drop method on a 3 month-interval-vaccination schedule for 9 months. Endo parasite control using Levamisole® was given twice in the wet and once in the dry season. Feed supplementation, using commercial chick mash, at estimated quantity of 30 gm per chick per day was provided for chicks for 3 months in two villages. Serum – samples, collected one month after each vaccination from 8 chickens per household were tested by the Haemagglutination inhibition test (HI). Faecal samples, also collected from 4 chickens per household were used to establish the helminth parasite infestation rates. The chick numbers and their weights were established weekly in each household for 3 months. Protection in chickens against Newcastle disease increased to mean HI log_2 titres of 4.5 and 3.7 with mean protection levels of 83% and 80% for I–2 thermostable and LaSota vaccines respectively. Mean parasite infestation rates dropped by 27%. Mean chick survival rates improved by 29% and chick age weights increased significantly. Overall, there was an increase in poultry stock numbers, mean household flock sizes and egg production. The health interventions were cost effective by cost benefit analysis.

INTRODUCTION

Free-range poultry production is the most predominant poultry production system in rural areas of Uganda, as in other African countries [1,2]. It is characterized by low inputs by in terms of health care for chickens, supplementary feeding, housing and other husbandry practices [3]. The chicken also have poor genetic potential. The overall effect is low productivity and high mortality rates in poultry.

Newcastle disease (ND) is the most important poultry disease due to the high prevalence, morbidity and mortality, [4,5,6]. The control of ND under free-range conditions is difficult to achieve. Vaccination is rarely provided for village chicken except in isolated cases in peri-urban areas [1]. This is due to the inaccessibility of the birds, lack of cold chain facilities for the vaccine and logistical problems. There is also general lack of awareness by rural farmers of the need to vaccinate chickens. The development of the ND thermostable vaccines was seen as an effort to offset some of the cold chain and logistical problems in vaccine distribution, delivery and use, thus making them more appropriate for use in vaccinating chickens in remote rural villages [7]. Parasites are also important in free-range chickens [8]. In Uganda, high prevalence of helminths in village chickens has been noted [9.10].

Feed resources, though abundant in Uganda, are rarely provided for free-range chicken. This study was designed to assess the performance of village chicken given the locally produced I-2 thermostable vaccine for protection against ND, parasite control using Levamisole®, feed supplementation for chicks. A cost-benefit study was done to assess the impact of the interventions.

MATERIALS AND METHODS

In two agro-ecological zones of Uganda, namely agro-pastoral and mountain zones, six villages were selected two per zone. These are areas of high rural poultry production under free-range management system [1, 11].

A total of 72 farmers were selected in the 6 villages on basis of household poultry characteristics, gender of the owner and capacity to participate in project activities.

Farmer sensitization meetings were organized in the villages to explain the project objectives and proposed interventions. In addition simple record keeping was introduced to the farmers using prepared simplified record forms.

Following introduction of farmers to simple record keeping during the sensitisation meetings, each farmer was required to enter poultry household data. This data was used to estimate the poultry study population.

A baseline study was conducted to assess the current health and production status of chicken in the project villages. Farmers were interviewed. The recorded household poultry data was confirmed. The chickens were examined. Serum and faecal samples were collected from at least 8 birds in each household. Serum samples were collected by bleeding the chicken. The samples were tested by the Haemagglutination inhibition test [12] Faecal samples were also collected from 4 chickens in each household. They were processed and examined for parasite eggs [8]

Two vaccines were used. A locally produced I-2 thermostable vaccine for chicken in the Mountain zone and LaSota for chicken in the agro-pastoral zone. The vaccines were given by the eye drop method, each bird receiving one dose per drop, using a calibrated eye dropper [13]. Vaccination was repeated every three months by the same methods and using the same vaccines for 9 months.

Endo parasite control in chickens was being done in 2 villages in each district using levamisole® (Norbrook, Africa E.PZ. Ltd). This was given following manufacturer's instructions. Each farmer was given instructions for use in drinking water depending on poultry flock size. The deworming exercise was done twice in the wet season and once in the dry season.

Commercial chick mash was provided for chicks in two villages in the Mountain zone following persistent high chick mortalities, in spite of the two health interventions for 9 months. This was decided after consultation with the field staff, assessment of the current poultry feed costs and transport costs of raw materials if feed were to be formulated locally. Chicks were provided with chick mash for 3 months. The number of chicks in each household was established. This was used to estimate the quantity of feed supplement required at a rate of 30 grams per chick per day [14]. Each farmer was required to feed chicks and mother hens with chick mash and water in a confined place / house or enclosure before releasing and later in the day to scavenge around the homestead. In addition each farmer was required to provide any other household supplements available e.g. food leftovers. One village in which no feed supplement was provided for chicks was used as control village. Every week, the numbers of chicks in each household were counted, their weights were also established by weighing 2–4 chicks of the same age using spring balance to establish average age weights.

Serum samples were collected and testing. Serum samples were collected from 4 chickens in each household by bleeding them before ND vaccination. These were tested by the Haemagglutination Inhibition Test (HI) [12] to assess the pre-vaccination sero-status. Serum samples were again collected as above from chickens in the same households. The Serum samples collected were tested as above to assess the level of protection.

A Newcastle disease challenge test was conducted for vaccinated chickens when a protection level of more than 90% was reached after testing serum-samples from randomly selected village chickens. Five vaccinated chickens were purchased from each of the project villages for the challenge test. For control, un-vaccinated local chicken from non–project area and exotic chicken reared on station were used. A locally isolated virulent ND virus isolate of Mean Death time of 52 hours at dilution of 10^{-9} was used for challenge in an isolated building on station. Each chicken received 0.1 ml of the virulent virus strain given intranasally. The birds were observed for 10 days. Feed and water were provided.

Faecal samples were collected from 4 chickens in each household during baseline studies to assess the parasite infestation rates. After Levamisole® treatment faecal samples were again collected from 4 chickens in the same households. The faecal samples were examined in the laboratory [8].

Each poultry owner / keeper was required to enter data on poultry stock numbers, losses, consumption and sales every month on prepared sheets. This data were be used to assesses household poultry production and dynamics

RESULTS

Project areas two agro-ecological zones with distinct farming systems climate, soil types and ethnicity. The agro – pastoral zone is a mixed life stock and crop farming zone in low lying areas in eastern Uganda. It is predominantly a cattle keeping area. Cattle are used for draught power in crop production. Other major livestock are goats and poultry. The soils are light sandy and loamy sandy. Rainfall is generally low with two peak periods. The area is sparsely populated and this allows for communal grazing practice in livestock management and free range poultry production. A total of 32 farmer s were selected (Table I)

The Mountain zone is high altitude zone with volcanic soils. The vegetation is mainly bamboo forest in the high lands and savannah in the low lands. Major crops are coffee and bananas grown on the slopes of the hills. The area is densely populated which can not allow high cattle and goat populations. Poultry keeping is major livestock enterprise. A total of 39 farmers were selected (Table I)

The population distributions as depicted in Table II had different protection status: before the intervention 51% in the agro-pastoral region compared to only 9% in the mountains were protected against ND (Table III). Both populations had high parasite counts (Table IV).

TABLE I. PROJECT AREA.

Zone	Districts	No. of Villages	Participating farmers F	M	T
Agro-pastoral	Soroti	3	22	10	32
Mountain	Mbale	3	29	10	39
Total		6	51	20	71

F = female farmers
M = male farmers
T = total number of farmers.

TABLE II. POULTRY PRODUCTION PARAMETERS BEFORE INTERVENTION.

Zone	Villages	Poultry Flock Structures Hens	Cocks	Growers	Chicks	Total	Flock size ranges	Egg production
Mountain	3	111	28	133	146	418	7-129	164
Agro pastoral	3	163	32	242	156	593	1-87	175
Totals	6	274	60	375	302	1011		339

TABLE III. POULTRY HEALTH PARAMETERS BEFORE INTERVENTION.

Zone	No. samples	Distribution of HI $\log_2$ titre										No. +ve	Mean HI titre	Protection level %
Hi log		0	1	2	3	4	5	6	7	8	9			
Agro pastoral	68	10	8	14	8	9	7	3	7	1	0	35	3.0	51
Mountain	62	25	27	4	1	0	3	0	2	0	0	6	1.08	9%

(a) Newcastle disease pre-vaccination sero – status and protection levels in chicken by Haemagglutination Inhibition (HI) test
HI $\log_2$ titre of 3 or above is considered positive and protecting against ND [12].

TABLE IV. HELMINTH PARASITE INFESTATION RATE IN CHICKEN.

Zone	No.	No. with paras.	parasite infest. rate %	Percentage infestation rate of major parasites identified Ascaridia	Capillaria	Hererakis	Strongyloides	Hymeno-leptis	Reilletina.	Coccidia
Mountain	64	31	48%	0	31	27	17	0	20	4.7
Agro-pastoral	64	26	40%	3	7	0	3	50	26	11

Interestingly after intervention the mountain population had much higher protection levels than the agro-pastoral area (Table V), which might result from the use of thermostable vaccine in the mountains versus the traditional La Sota strain. Never the eless the protection levels were suffciant to protect all birds against a challenge with NDV wild type (Table VI)

Standart anti-endoparasitic treatment helped to reduce the worm burden by 50–75% (Table VII)

TABLE V. POST VACCINATION SEROLOGICAL STATUS AND PERCENTAGE PROTECTION LEVELS BY HI TEST IN VACCINATED CHICKEN.

Zone	Vaccine used		Months 0	3	6	9
Mountain	I-2	Mean HI log_2 titres	3.0	3.7	4.7	5.2
		% protection level	51%	70%	90%	90%
Agro - pastoral	Lasota	Mean HI log_2 titres	1.08	2.6	4.7	3.75
		% production level	9%	52%	96%	92%

Mean log_2 titre of 3 or above is considered positive and protecting against NCD [12]

TABLE VI. NCD CHALLENGE RESULTS IN RANDOMLY SELECTED VACCINATED CHICKEN.

Days post challenge test	Number surviving / dead birds LA	LA	LA	I-2	I-2	I-2	NV	NS
0	5	5	5	5	5	5	5	5
1	5	5	5	5	5	5	5	5
2	5	5	5	5	5	5	5	5
3	5	5	5	5	5	5	3	4
4	5	5	5	5	5	5	1	1
5	5	5	5	5	5	5	1	0
6	5	5	5	5	5	5	0	0
7	5	5	5	5	5	5	0	0
8	5	5	5	5	5	5	0	0

No. of chickens alive / dead
LA _ Vaccinated with Lasota vaccine
I-2 - Vaccinated with I – 2 vaccine
NV – Non - vaccinated local village birds
NS – Non-Vaccinated exotic birds kept on station

Helminth infestation rates in chicken after Levamisole® treatment

TABLE VII. PARASITE INFESTATION RATES.

Zone	Time	No.	No. with paras.	Infest. rate %	Parasites species present in samples (%)						
					Ascaridia	Capillaria	Heterakis	Strongy loides	Hymenolepis	Railletina	Coccid.
Montaine	BT	64	31	48%	0%	31%	27.5%	17%	0%	20%	4.7%
Agro pastoral	BT	64	26	40%	3%	7%	0%	3%	50%	26%	11%
Montaine	AT	56	13	23%	23%	23%	0%	38%	0%	0%	15%
Agro pastoral	AT	54	6	11%	0%	0%	100%	0%	0%	0%	0%

BT – Before treatments, AT – After treatment
Poultry production after interventions

The flock size after intervention doubled already after 6 months (Table VIII). In this calculation a certain offtake of birds is not taken into account. The number of cocks for instance did not match the herd structure development. This is as well evident in Table IX.

TABLE VIII. **(I)**MONTAINE ZONE AT 3 MONTHS.

Village code	Flock size ranges	Flock structures					Egg production
		Hens	Cocks	Growers	Chicks	Total	
D	5-36	52	4	64	48	168	124
E	13-68	37	15	52	64	168	93
F	5-34	31	4	43	52	130	113
	Totals	120	23	159	164	466	330

After 6 months

(II) MONTAINE ZONE AT 6 MONTHS.

Village code	Flock size ranges	Flock structures					Egg production
		Hens	Cocks	Growers	Chicks	Total	
D	7-67	72	10	117	230	429	224
E	14-180	56	17	93	150	247	129
F	5-48	68	28	139	99	334	96
	Totals	146	55	349	479	1079	499

After 9 months

(III) MONTAINE ZONE AT 9 MONTHS.

Village code	Flock size ranges	Flock structures					Egg production
		Hens	Cocks	Growers	Chicks	Total	
D	7-114	73	9	55	165	302	253
E	6-103	58	23	88	191	390	149
F	5-27	55	9	87	121	272	96
	Totals	216	41	230	477	964	498

(IV) TOTAL POULTRY POPULATIONS AND EGG PRODUCTION.

Months	Hens	Cocks	Growers	Chicks	Totals	Egg production
3	120	23	159	164	466	330
6	146	55	349	479	1029	499
9	216	41	230	477	964	488
Total	482	119	738	1120	2459	1327

TABLE IX. SUMMARY POULTRY PRODUCTION DATA FOR MONTAINE ZONE.

Parameter	Baseline	At 3 months	At 6 months	At 9 months
Flock sizes	7–129	5–68	5–180	5–114
Mean flock sizes	22	20	34	29
Cock hen ratio	1:4	1:5	1:3	1:5
Total poultry	418	466	1023	895
Total egg produced	164	330	499	498

TABLE X. POULTRY DYNAMICS.

(I) Proportion of dynamic and remaining poultry stock.

Months	Total flocks	Dynamic flock		Remaining flock	
	No.	No.	%	No.	%
3	1001	535	43.4%	466	46.5%
6	1829	806	44.0%	1023	56.5%
9	1314	419	31.8%	896	68.2%
Total	4144	1760	40.8%	2453	59.2%

(II) Proportion of 4 major factors in poultry dynamics identified.

Months	Dynamic Flock	Chicken losses		Chicken consumption		Chicken sales		Chicken ex-change for livestock	
	No.	No.	%	No.	%	No.	%	No.	%
3	535	381	72.1%	71	13.2%	61	11.4%	22	4.1%
6	806	513	63.6%	130	16.1%	93	11.5%	70	8.6%
9	419	330	78%	45	10.7%	19	4.5%	25	5.9%
Total	1760	1224	69.5%	246	13.9%	173	9.8%	117	6.6%

(III) Chicken losses – Proportion of different chicken groups.

Months	Total Chicken loses	Chicks		Growers		Hens		Cocks	
	No.	No.	%	No.	%	No.	%	No.	%
3	381	204	53.3%	103	27%	55	14.4%	19	4.9%
6	513	220	42.8%	117	22.8%	156	30.4%	20	3.8%
9	332	252	76.3%	60	18%	17	5.1%	3	0.6%
Total	1224	676	55.2%	280	22.8%	228	18.6%	42	3.4%

Both populations increased in size during the first 6 months of interventions (Table X). The decline specifically in the agro-pastoral area is due to civil unrest during this time.

TABLE XI. AGRO-PASTORAL ZONE; AT **3 MONTHS.**

Village code	Flock sizes	Flock structures					
		Hens	Cocks	Growers	Chicks	Total	Egg pro.
A	2-35	75	19	68	72	234	102
B	4-38	109	28	161	60	358	95
C	2-58	81	21	98	92	292	153
	Totals	265	68	327	224	884	350

After 6 months.

Village code	Flock size ranges	Flock structures					
		Hens	Cocks	Growers	Chicks	Total	Egg prod.
A	3-34	84	18	128	108	338	184
B	2-29	157	23	361	119	660	104
C	5-30	155	28	245	113	541	327
	Totals	396	69	734	340	1539	615

After 9 months.

Village code	Poultry flock size	Flock structures					
		Hens	Cocks	Growers	Chicks	Total	Egg pro.
A	4-34	59	28	69	34	190	193
B	2-33	66	18	71	67	222	111
C	6-59	96	50	242	102	490	96
	Totals	221	96	382	203	902	400

Summary

Months	Hens	Cocks	Growers	Chicks	Total	Egg production
3	265	68	327	224	884	350
6	396	69	734	340	1539	615
9	221	96	382	203	902	400
Total	882	233	1443	767	3325	1365

TABLE XII. SUMMARY POULTRY PRODUCTION DATA FOR AGRO-PASTORAL ZONE.

Parameter	Baseline	At 3 months	At 6 months	At 9 months
Flock sizes	1–87	2–58	2–34	2–59
Mean flock sizes	16	17	16	17
Cock hen ratio	1:5	1:4	1:5	1:2
Total poultry population	593	884	1539	902
Total egg prod.	175	350	615	400

TABLE XIII. POULTRY DYNAMICS

(a) Proportion of dynamic and remaining poultry flock

Months	Total poultry flock	Dynamic flock		Remaining flock	
		No.	%	No.	%
3	1324	440	33%	884	67%
6	2333	794	34%	1539	66%
9	1961	1059	54%	902	46%
Total	5618	2293	40.8%	3325	59.2%

(a) Proportions of 4 major factors in poultry dynamics

Months	Dynamic flock	Chicken losses		Chicken consumption		Chicken sales		Chicken exchange for livestock	
	No.	No.	%	No.	%	No.	%	No.	%
3	440	298	67.6%	100	22.7%	29	6.5%	10	2.2%
6	794	560	70.5%	170	21.4%	44	5.5%	20	2.5%
9	1059	538	50.8%	342	32.2%	119	11.2%	60	5.6%
Total	2293	1396	60.8%	612	26.6%	192	8.4%	90	3.9%

(b) Chicken losses – proportions of different chicken groups

Months	Total loses	Chicken losses		Growers		Hens		Cocks	
	No.	No.	%	No.	%	No.	%	No.	%
3	298	178	59%	38	12.7%	78	26%	6	2%
6	560	378	67.8%	75	13.44%	92	16.5%	15	2.6%
9	538	438	81.2%	44	8.2%	46	8.5%	10	1.8%
Total	1396	994	71.2%	157	11.2%	216	15.4%	31	2.2%

Effects of feed supplementation of chicks in Mountain zone

TABLE XIV. EFFECT OF FEED SUPPLEMETATION ON CHICK SURVIVAL RATES.

Test village – 1

Time months	No. of households	No. chicks	Feed quantity (kg)	No. of chicks lost	% chick mortality	% chick survival rate
0	10	313	0	154	49.2%	50.7%
1	10	159	143	9	5.6%	94%
2	10	169	152	13	7.7%	92%
3	10	335	301	79	23.5%	76%

Test village – 2

Time months	No. of households	No. chicks	Feed quantity (kg)	No. of chicks lost	% chick mortality	% chick survival rate
0	10	241	0	68	28%	71%
1	10	173	155	13	7.5%	92%
2	10	192	172	7	3.7%	96%
3	10	234	210	23	9.8%	90%

Control village – 3

Time months	No. of households	No. chicks	Feed quantity (kg)	No. of chicks lost	% chick mortality	% chick survival rate
0	15	136	0	30	22%	77.9%
1	15	231	0	97	41.9%	58%
2	15	286	0	165	57.6%	42%
3	15	174	0	88	50.5%	49%

TABLE XV. EFFECT OF FEED SUPPLEMETATION ON CHICK AGE WEIGHTS.

Age weeks	1	2	3	4	5	6	7	8	9	10	11	12
Weights (g) in test villages	25-125	125-150	137-250	208-825	375-750	875	800-1000	525-1065	-	925	-	-
Mean	78	137	194	427	583	875	900	779	-	925	-	-
Weights (g) in control village	25-50	50	112-250	100-291	250-400	525	-	550	-	625	-	1625
Mean	38	50	183	199	341	525	-	550	-	625	-	1625

- No chicks or died Supplement feed provision for chicks using commercial chick mash significantly improved the weight gains (P<0.001, t = 5.2, df = 9)

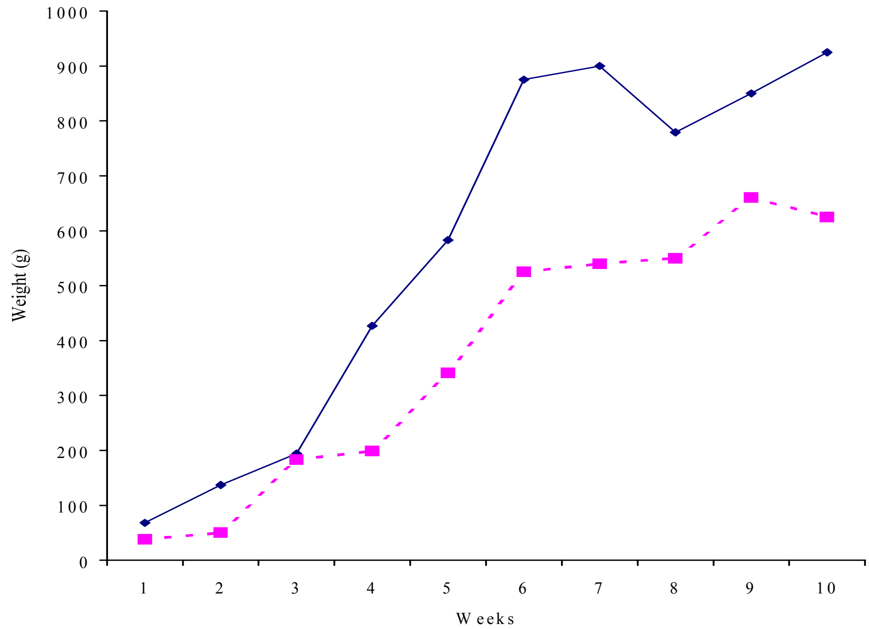

FIG. 1. Results of the weights of chicks fed supplementary mash compared to controls during a 10 week period (♦ - interventions, ■ – controls)

COST-BENEFIT ANALYSIS OF THE INTERVENTIONS IN RURAL POULTRY PRODUCTION IN TWO ZONES OF UGANDA

Interventions for health

The following interventions were maintained during the trials

Mountain Zone

- Newcastle disease vaccination using the I-2 thermostable vaccine produced locally using SPF eggs. **NCD Vaccination** done three times in one year using a three months vaccination schedule.
- Endo parasite control using levamisole®.
- Supplementary feed for chicken in two villages using commercial chick mash

Major Inputs:

- Vaccine production – SPF eggs, seed virus (Master) and laboratory supplies
- Staff allowances during production
- Fuel cost for incidental movements

Since work was done within the Institute, staff allowances and fuel expenses were limited. The major expenses were in the cost of SPF eggs.

Cost calculation for 150 SPF eggs

Cost of eggs	=		172.5 Euro
Air freight	=		200 Euro
Handling costs	=		22,230 Ug shs
Clearing costs	=		99,450 Ug shs
Transportation to labs	=		10,000 Ug shs
Cost of eggs	=	2350 x 172.5	405,375Ug shs
Air freight	=	470,000 Ug shs	

Total cost of 150 SPF eggs + clearing, handling, and transportation	=	1,007,055 Ug shs
For this purpose, cost of vaccine production can be assumed to approximately	=	1,007,055 Ug shs

Exchange rate for 1 Euro approximately 2350 Ug shs
150 SPF eggs produced approximately 140,000 doses of I–2 vaccine of EID $_{50}$ 10^8 per ml, 140,000 vaccine doses cost 1007,055 Ug shs.
Cost of 1 dose of vaccine = 1007.055 ÷ 140,000 = 7.19 Ug shs.

Vaccination of chicken with I–2 vaccine

Vaccination cost = cost of vaccine + field expenses

= cost of vaccine + (Staff allowances + Fuel costs)

assuming 1 dose of vaccine was used per bird each time – calibrated eye dropper was used.

1st vaccination

No of birds vaccinated = 466
Cost of field expenses was 256,200/= cost of vaccinating 466
= cost of 466 doses of vaccine + field expenses
= (466 x 7.19) + 256.200
= 3350.54 + 256,200
= 259550.54
Cost of vaccinating 1 bird = 259550.54 ÷ 466 birds
= 556.9 Ug Shs

2nd vaccination

No. of birds vaccinated	=	763
Cost of field expenses was	=	327,000/=
Cost of vaccinating 763 birds	=	(763 x 7.19) + 327,000
	=	5485.97 + 327,000
	=	332,485.97
Cost of vaccinating 1 bird was	=	435.76

3rd vaccination

No. of birds	=	943
Cost of their vaccination was	=	(943 x 7.19) + 330800 (field)
	=	337580.17
cost of vaccinating 1 bird was	=	33750.17 ÷ 943
	=	357.9 Ug Shs

Average cost of vaccinating 1 bird (once) was = (556.9 + 435.7 + 357.9) ÷ 3
= 450.1 Ug shs

Three vaccinations were given
cost of vaccinating 1 bird (for 1 year) 3 times: 450.1 x 3 = 1350.5 Ug shs
Total cost of vaccine used was 3350.50 + 5485.9 + 6780 = 15,615/= at a cost of 7.19/= per dose

1 US dollar approximately 1940 Ug shs

Average cost of vaccinating 1 bird (1x) was 0.23 U$
Average cost of vaccinating 1 bird 3x) was 0.69 U$

Endo parasite control using Levamisole®

Parasite control : Cost of Levamisole® + field expenses
Cost of Levamisole® (Staff allowances + field expenses)
since this activity was done during vaccination, the no field expenses had to covered.

1st Deworming (Wet season)

No. of bottles of Levamisole® used = 2 each costing 2,500/=		
Cost of Levamisole® used was		5,000/=
No. of birds dewormed (2 villages)		336
Cost of deworming 1 bird	= 5000/336	14.8/=

2nd Deworming (Wet season)

No. of bottles of Levamisole® used = 3 each costing 2,500/=		
Cost of Levamisole® used was	2,500/= x 3	7,500/=
No. of birds dewormed (2 villages)		429
Cost of deworming 1 bird	= 7500/429	17.4/=

3rd Deworming (Dry season)

No. of bottles of Levamisole® used = 4 each costing 2,500/=		
Cost of Levamisole® used was	2,500/= x 4	10,000/=
No. of birds dewormed (2 villages)		692
Cost of deworming 1 bird	= 10000/692	14.4/=

The average cost of deworming/bird (14.8 + 17.4 + 14.4) / 3 = 15.5
Deworming was done 3 times above (2 wet + 1 dry)
Cost deworming 1 bird (x3) was = 3 x 15.5 = 46.5 Ug shs

Cost of health interventions provided for 1 bird/year for in the Montaine zone was = 1350.5 + 46.5 = 1397 Ug shs.
At the rate of 1 dollar for 1940 Ug shs 1397 Ugshs = 0.72 US $

Therefore cost of health provision for 1 bird for 1 year (Vaccination + deworming) was 0.72 US $

Financial analysis of the health interventions for village chicken in the Mountain zone

Interventions - ND vaccination using the I-2 vaccine
- Deworming using Levamisole®

Main inputs:

Vaccination
Total cost of I–2 vaccine used is estimated at 15,615/=
Deworming
Total cost of Levamisole® used is estimated at 22,500/=
Field expenses
During vaccination and deworming = 914,000/=

Total variable costs	=	952,115/=
Cost of initial chicken	=	691,100/=
Total inputs	=	1,643,215 = **847 US $**

Out puts.

Eggs –Each egg estimated to cost 100/= =0.05 US $

Egg output value (1440)	=	144,000/=
Value of Eggs from sales (419)	=	41,900/=
Value of Eggs consumed	=	120,600/=
Value of eggs hatched	=	650,000/=
Total value of egg out put	**=**	**956,600/= 493US $**

Chicken value
Average village chicken estimated to cost 2700/=
output value of chicken sold = 869,100/=
Value of chicken consumed = 866,100/=
Value of chicken exchanged for livestock = 629,300/=
End stock value of chicken = 1,297,700
Total out put value of chicken = 3,662,800 ~1,888 US $
Income from chicken enterprise = 956,600 + 3,662,800
= 4,619,400/= ~**2381 US $**

Gross margin = 4,619,400–1,643,215 =2,976,185/= 1,534 US $
Value of chicken lost = 1,655,100/=
Gross margin – value of chicken lost = 1,312,085/=
With 50% reduction of the losses = 827,550/=

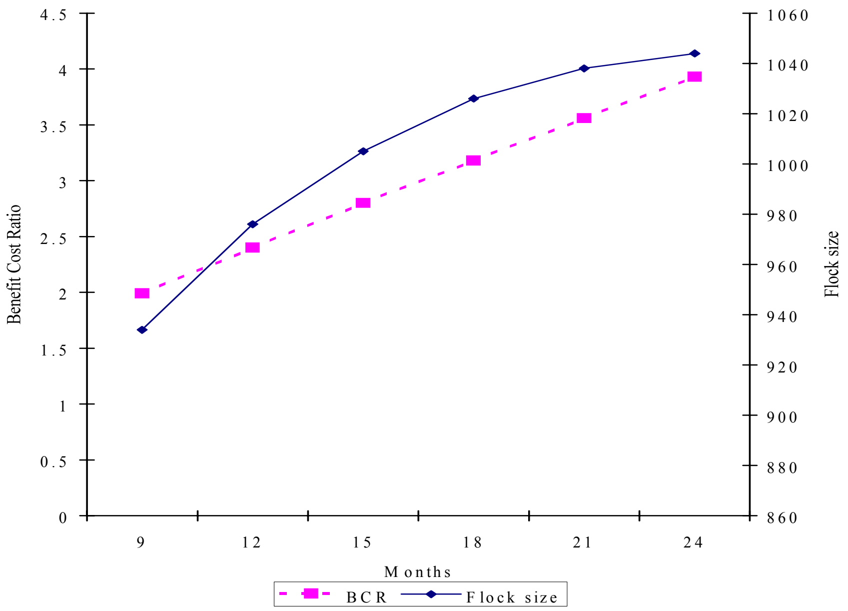

FIG. 2. Projected variations of benefit cost ratio and flock sizes up to 24 months when farmers adopt routine vaccination and deworming in the AGRO -PASTORAL ZONE

Interventions in the agro-pastoral zone

- Newcastle disease Vaccination done using the cold chain Lasota vaccine purchased from local stockists of Veterinary drugs.
- Endo parasite control using levamisole®

Major Inputs

Cost of vaccine.
Vaccination costs: cost of the vaccine + field expenses.

1st Vaccination

No. of birds = 884
Cost of field expenses claimed = 663,400
Cost of vaccine = 4000/= per bottle for 1000 doses
No. of bottles used 4=4x4,000=16,000/= for 4,000 doses
Cost of vaccinating 884 birds = 663,400 + 16,000 = 679,400
Cost of vaccinating 1 birds = 663,400/884 = 768.5

2nd Vaccination

No. of birds = 1529
Cost of field expenses was = 670,200
Cost of vaccine = 4 bottles = 4 x 4000 = 16,000/= for 4000 doses
No. of vaccinating 1539 birds = 670200 + 16,000 = 686,200
No. of vaccinating 1 bird = 686,200/1539 = 445.8

3rd Vaccination

No. of birds	=	902
Cost of field expenses was	=	780,000
Cost of vaccine	=	16,000
Cost of vaccinating 902 birds = 7800000 + 16,000	=	796,000
Cost of vaccinating 1 bird = 796,000/902	=	882.4

Average cost vaccinating 1 bird = (768.5 + 445.8 +882.4) / 3 = 698.Ug shs

Cost of vaccinating 1 bird (x 3) = 698 x 3	=	2094/=
Cost of 1 dose of vaccine = 4000 / 1000	=	4/=.
Field expenses for vaccinating 1 bird was 698–4	=	694
Field expenses for vaccinating 1 birds (3x) = 694 x 3	=	2,082
Cost of vaccinating 1 bird (x 1) = 698 / 1940	=	0.36 US $
(x3) = 2094 / 1940	=	1.08 US $

Total cost of vaccination used was 24.7 US $.

Endo parasite control in the Agro – pastoral zone

1st Deworming – Wet season.

No. of bottles of levamisole® used 2 @ 2500	=	5000/=
No. of birds in 2 villages	=	592
Cost of deworming 1 bird = 5000/592	=	8.4 Ug shs

2nd Deworming – Wet season.

No. of bottles of levamisole® used 3 x 25000	=	7500/=
No. of birds	=	998
Cost of deworming 1 bird = 7500/998	=	7.5 Ug shs

3rd Deworming – Dry season.

No. of bottles of levamisole used 2 x 25000	=	5000/=
No. of birds	=	412
Cost of deworming 1 bird = 5000/412	=	12.1 Ug shs

Average cost of deworming 1 bird = (8.4 + 7.5 + 12.1)/ 3 = 9.3 Ug shs

Cost of deworming 1 bird (x3) = 9.3 x 3 = 27.9 Ug shs

Therefore cost of deworming 1 bird in the year was 27.9 Ug shs

Cost of health intervention for 1 bird for 1 year was cost of vaccine + cost of deworming = 2094 + 27.9 = 2121 Ug shs

Main Inputs

Vaccination

Cost of vaccine used	=	48,000/=	
Deworming			
Total cost of Levamisole	=	17,500/=	
Field expenses	=	2,113,600/=	
Total variable costs	=	2,179,100/=	
Cost of initial chicken	=	969,600/=	
Total inputs	=	3,148,700/=	1,623 US $

Out puts.

Eggs

Each out value	=	154,000/=
Value of eggs from sales	=	3,800/=
Value of eggs consumed	=	87,300/=
Value of eggs hatched	=	714,700/=
Total out put value of eggs	=	959,100/= 494 US $

Chicken

Output value of chicken sold	=	719,700/=
Output value of chicken consumed	=	1,652,400/=
Output value of chicken exchanged for livestock	=	282,600/=
End – stock value of chicken	=	1,656,200/=
Total out put value from chicken	=	4,310,900= 2,222 US $
Total output value from chicken and eggs	=	5,270,000/= 2,716 US $
Gross margin	=	2,121,300/= 1,093 US $
value of chicken lost	=	1,422,200/=
Gross margin - value of chicken lost	=	699,100/=
50% reduction of losses	=	711,100/=
gross margin after 505 reduction of losses	=	2,832,400/=

50% reduction of the losses = 827,550/=

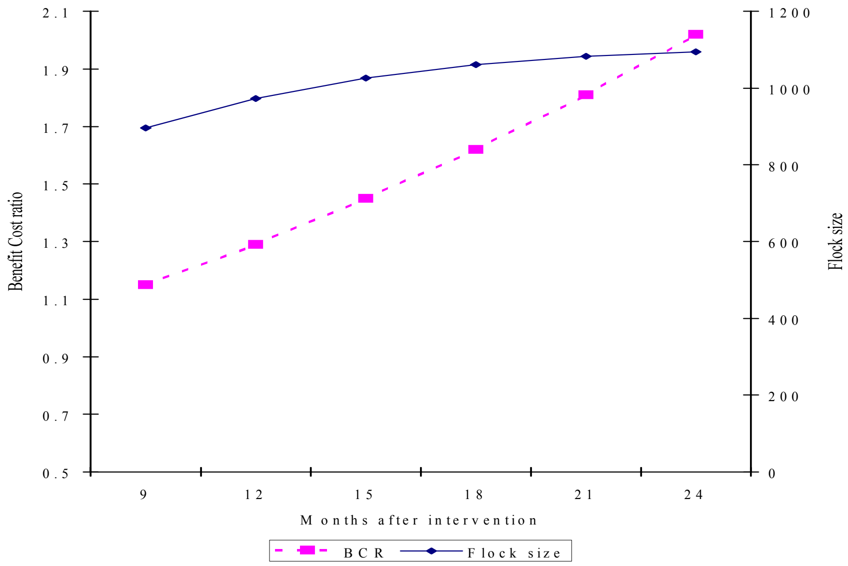

FIG. 3. Projected variations of Benefit cost ratio and flock size up to 24 months after farmers adopt routine vaccination and deworming in the Agro – pastoral zone

Supplementary feeding for chicks using commercial chick mash in Mountain zone

Inputs

Cost of 1 kg of feed		=	378
Total quantity of feed provided		=	1133 kg
Total cost of chick mash provided for 3 months		=	428,274/=
Field expenses for 3 months		=	893,650
Total variable costs		=	1,321,924
Cost of initial value of chick stock	332 x 500	=	166,000
Total inputs		1,488,094 ~767 US $	

Output

Growers		
Average value of one grower	=	1,000
Total No. of growers	=	569
Total value of growers 569 x 1000	=	569,000/=
No. of chick loses	=	237
Value of chick losses 237 x 500	=	118,500/=

With 100% survival

Total No. of growers	=	901
Total value 901 x 1000	=	901,000/=

Gross margin with 100% survival would be
901,000 – 1,488,094 = -587,094
Gross margin with No. field expenses with 100% survival of chicks
901,00 – (428,274 + 166,000) = 306,726/=

DISCUSSION

Newcastle disease and parasites control interventions for village chickens in two agro ecological zones were selected based on their economic importance in rural poultry production in Uganda [1,6]. For ND control LaSota and the I–2 thermostable vaccines were used. LaSota vaccine has been in use for chicken vaccination against ND in Uganda. Its capacity to protect chicken is well established especially in intensive poultry production system. The I-2 thermostable vaccine was being introduced for rural use. A high protection level in chicken against ND was attained in terms of HI antibody titres and ability of the vaccinated chicken to resist challenge by a local ND virulent virus strain, this is in agreement with the findings of other workers [13,14]. However, 100% protection level in village chicken was not attained by either of the vaccines inspite of the application method and schedule used. The eye drop method for ND vaccine application on a 3 month interval is recommended to produce high immune responses in chicken [13]. Apart from the vaccine type, method of application, host and managemental factors are also vital in the development of protective immunity to ND in chicken [14]. This being a free-range production system, it is possible that host and management factors affected the development of immunity in chicken. It shows the need for continuous vaccination to attain maximum protection in free–range chicken.

Before introduction of parasite control measures, baseline studies established a wide range of helminth parasites. This is expected in a free-range system [8]. Earlier studies conducted in village chickens in Uganda also indicated similar findings [9,10]. The use of Levamisole® for parasite control was considered appropriate because of its wide spectrum activity on helminths. However, Ascaridia, Heterakis, and Capillaria species were still recovered after treatment. There was evidence of parasite re-infestation and possible resistance (Table VII). This is possible under favourable environmental conditions. This may not allow attainment of total parasite control in chicken in a free – range system.

Feed supplementation for chicken is a necessary managemental practice for free–range chicken production, [16]. Its provision for chicks in this study was justifiable. Poultry dynamics data collected in the two zones in the 9 months period showed high chick mortality demanding additional intervention to the ND and parasite control. Feed supplementation was chosen in order to increase chick growth rates and reduce straying of chicks far from the homesteads. It would reduce chances of predation, one of the major causes of chick mortality, and contact with other birds in the event of other disease outbreaks. The option of commercial chick mash was taken after consideration of transport costs for local materials needed for feed formulation and labour implications for the farmers for feeds formulation. Although a provision of 10gm of concentrate feed for per chick per day is adequate [14], provision of 30gm per chick per day was adopted to cater for the different chick age groups in the homesteads and for the mother hens. Both the chick survival and growth rates improved. The chicks can thus reach production stage and market weights earlier. Poultry populations, egg production and mean household flock sizes as indicators of poultry production increased in the households in the zones. This was attributed to the health intervention especially ND vaccination. In the Mountain zone this trend was maintained during 9 months study period. In agro-pastoral zone, there was slight decline after the 6 months. This was attributed to the civil unrest which affected the area. Poultry dynamics data after 6 months showed a sudden increase in chicken consumption, sales and exchange for other livestock (Table XIIIc). This was probably an effort by the farmers to dispose of their poultry stocks during the civil disorder.

Financial analyses of the health interventions were cost effective. This can be attributed to increased household poultry populations and egg production and reduction in chicken losses. If the farmers adopted the technologies, there would be further reduction on or minimal field expenses in the provision of the interventions, which would further increase the gross margins. Feed supplementation using commercial chick mash can possibly become cost effective when there are minimal chick losses, birds reach market weights and become productive. This is a possible achievement which is worth exploring in the free range system in future studies.

CONCLUSIONS

The I-2 vaccine has the capacity to protect village chicken against Newcastle disease leading to improved production under field conditions in Uganda. Total control of poultry parasites may not be attained under free range system. Feed supplementation for chicks can indirectly contribute to improved survival under free range poultry management system

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EVALUATION OF HEALTH AND PRODUCTIVITY OF FAMILY POULTRY IN EASTERN TANZANIA AND THE IMPACT OF CONTROLLING NEWCASTLE DISEASE

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Abstract

During the period of February 2003 and April 2004, a study was undertaken to implement intervention measures towards constraints limiting family chicken production in Eastern Tanzania. The study involved continuing with the control of Newcastle disease through vaccination using heat stable I-2 vaccine by eye-drop inoculation in six villages in two zones involving 43 households so as to ensure survival of birds in ND outbreaks. Simultaneously, Fowl pox control by vaccination was also implemented Improvement of shelter for chicks so as to avoid mortalities arising from diseases, predation and nutritional disorders was also attempted. A total of 246 serum samples from local chickens flocks in Dar es Salaam, Coast, Arusha and Singida Regions were tested for specific antibodies to IBD/ Gumboro Disease by Enzyme-linked immunosorbent assays (ELISA) using a commercial kit FlockChek from Idexx Europe B.V Serological results revealed a prevalence of approximately 2.85% (7/246). The fowl pox vaccine was effective in preventing Fowl Pox outbreaks. Realising the health problems posed by Fowl pox following ND control, ADRI initiated a research project aiming at developing a local vaccine. Several strains of avian pox virus were isolated from local chickens, commercial chickens, turkeys, guinea fowl and pigeons. Candidate vaccinal strains have been identified after carry out multiple passages and determination of antigenic properties and they are now being tested in a controlled experiment to determine safety and efficacy.

The study has shown that given the conditions that exist in the villages, use of thermostable I-2 vaccine administered by the eye-drop method once every four months will protect the local chickens against ND infection The I-2 vaccine proved to be reliable (efficacy was computed at 79%). and easy-to-use for most people.

The socio-economic data was used to compute partial budget whereby the profit was calculated at 81% and household income was 2.5 times returns on investment and hence the vaccination intervention was successful

INTRODUCTION

In Tanzania good statistics on the poultry population are not available but the total number is believed to be in the order of 30,900,000 chickens (1994/95 National Sample Census of Agriculture Report, volume II). Within this number are found: 26,400,000 local village chickens kept predominantly in the rural areas; commercial birds including broiler and layer chickens about 3,200,000. A turnover of 20 million total commercial chickens per year is estimated. Around 72% of agricultural households keep chickens.

Of all livestock kept in Tanzania, local chickens are the most widely evenly distributed throughout the country (Boki, 2000). However, a large portion of the national total is found in Lake Zone and Southern highlands and especially in Mbeya, Shinyanga and Iringa. In Southern regions particularly Mtwara, the role of family chicken as a commodity is higher than anywhere else in the country due to low numbers or total absence of other livestock. The major farmyard management system is: — free ranging (scavengers), — with small shelter provided for the night.

There are several advantages of the traditional poultry husbandry system that includes: absence of religious objections for the consumption of poultry, both poultry meat and the eggs contain protein of a high biological value, women and children are often in charge of the farmyard poultry thereby getting an opportunity to uplift themselves and earning an income. The production of poultry is a relatively efficient and fast way to turn raw and waste materials into valuable animal protein: poultry has a high feed conversion compared to other livestock, no cold chain is needed; the birds can be bought alive, Poultry litter is a very efficient fertilizer, farmers are, in principle, more willing to sell poultry and their products rather than the larger livestock. Poultry represent a regular cash flow, whereas ruminants represent more of a capital reserve. Other uses of local chickens in Tanzania are: To meet 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 in children illnesses, female infertilities, abnormally prolonged menstrual periods and simple fractures. Local chickens play an important role in social life in villages during ceremonies, rituals, in traditional healing and gifts to respectable guests.

Large markets for rural chickens are found in urban centres. In order to exploit urban markets, traders have to transport live local birds for long distances using large wicker baskets on trucks and on roof-tops of buses from centres of production in central zones (Dodoma and Singida) to centres of consumption particularly Dar es Salaam. Singida region is probably the only area where local chicken keeping has assumed a serious business outlook.

Many international organisations, animal scientists and veterinarians are now becoming interested in the potential productivity of village chickens. The causes of low productivity are being defined and suitable interventions are being designed. Under the auspices of International Atomic Energy Agency (I.A.E.A), a research project on family poultry was conducted from March 1999 to April 2004, to try and identify the major disease conditions and factors limiting family chicken production in Coast and Dar es Salaam regions of Tanzania. Newcastle disease was revealed to be the major constraint inhibiting rural chicken development followed closely by poor housing that causes high chick mortality through diseases and predation. Therefore subsequent interventions directed towards these major limitations of rural chicken production were planned and implemented. The project reported here sought to address the issue through well-defined objectives.

The overall objective of this project in Tanzania was to improve village poultry production through the introduction of cost effective and sustainable interventions.

The work undertaken in the final 18 months of the project aimed at fulfilling the following specific objectives:

To continue with the control of Newcastle disease through vaccination using heat stable I-2 vaccine by eye-drop inoculation so as to ensure survival of birds in ND outbreaks.

To reduce deaths of chicks through improvement of Fowl pox control. With the control of ND, several other diseases have surfaced demanding an attention previously unwarranted.

To reduce death of chicks through improvement of shelter for chicks. The low number of growers and chicks noted in the previous survey was mainly due to high chick mortality (that reached over 30%) resulting from diseases, predation and nutritional disorders. Housing for the chicks needed to be improved to assist in disease control and in particular the predation.

To test the frozen sera collected in the previous survey and preserved at ADRI for specific antibodies to Infectious Bursal Disease (IBD)/ Gumboro Disease by Enzyme-linked immunosorbent assay (ELISA) technique.

MATERIALS AND METHODS

Selection of study areas

Study sites were those selected in 1999, for the initial phase of project implementation. Two ecological zones in the coast (zone I) and Dar es Salaam region (zone II) of Eastern Tanzania were selected for the field study. The weather in the zones is characterised by marked seasonality: dry season (June–October, January–March) and rainy seasons {March–May (long rains), November–December, (short rains)}. Field visits were centred on three villages (Mwendapole, Pangani, Boko) in Kibaha district (in zone I) and three others (Toangoma, Mbande and Gezaulole) in Temeke district (in zone II) as shown in table I. With the assistance of Government & Livestock Field Officers responsible for the respective villages, 6–11 farmers preferably female who keep family chicken were identified from each village. Visits were then made to the respective village for the purpose of explaining the objectives of the research project to the village leadership, villagers and particularly so to the participants of the project. The latter were notified of specific dates when they will be visited for data and sample collections and vaccinations.

TABLE I. DATA FROM SIX VILLAGES IN TWO ECOLOGICAL ZONES USED FOR THE MONITORED NEWCASTLE DISEASE VACCINATION STUDY.

District	Village	No. of households selected	Flock size range	No. of sera taken			Average no. birds vaccinated
				A	B	C	
Kibaha	Mwendapole	6	1–34	56	32	42	102
	Pangani	11	10–102	76	69	55	317
	Boko	6	10–48	49	37	36	126
Temeke	Toangoma	6	6–38	51	41	40	112
	Mmbande	7	9–100	69	40	37	211
	Gezaulole	7	9–88	61	33	75	234
Total				362	252	285	1102

A, B and C denotes number of serum samples taken prevaccination, 2 weeks and 15 weeks post vaccination respectively.

Field activities

During the period of April 2003 and April 2004, the project, activities were carried out both in the field and in the laboratory in accordance with standardised protocols agreed during the 3rd Research Coordination Meeting (RCM) of the Coordinated Research Programme held at Quatre Bornes, Mauritius, 6–10 May 2002 The main field activities were as follows:

Sensitisation of local communities to the project activities, and notification of poultry keepers of the dates of sampling visits by Animal Diseases Research Institute (ADRI) field teams, Examination of chickens for any sign of disease or parasites, conducting autopsy on 6 sick or dead birds, Collection of background epidemiological data, Administration of socio-economic questionnaires on poultry keeping and husbandry practices, Recording of all field information on standard data sheets, Vaccination against ND and Fowl pox, Poultry Population dynamics recording, Design of shelter through PRA techniques, Procurement of feeds. The 43 households from the 6 villages were used for ND vaccination as the experimental units. The non-vaccinated households in the neighbourhood were considered as controls. Initial visits were made to the villages for sensitisation on the importance of the intended interventions. They were notified of the vaccination and sample collection dates. In total 16 visits were made. All the 1352 chickens identified during the surveys and newly hatched chicks belonging to the 43 households were vaccinated through the eye drop route using thermo stable vaccine I-2 strain locally produced at ADRI. 3 Vaccinations at intervals of 4 months were conducted during the months of February, June and October. These periods are now the accepted vaccination calendar in the involved villages.

The laboratory activities

Recording all information from field sheets and from laboratory tests in PC databases, Sera previously collected in cryo-tubes and preserved at –20°C were employed for testing of specific antibodies to ND virus (NDV) and IBDV using the ELISA test to detect antibodies against ND *Fowl pox*

A commercial vaccine from Shafit Biological Laboratories Israel was used for controlling the disease. The vaccine was reconstituted by transferring 5 ml of diluent into the freeze-dried vaccine before it was applied by dipping the needle in the vaccine suspension and stabbing through the underside skin of the wing web or the skin of the thigh. Each bird was vaccinated only once, preferably during the first round of I-2 ND vaccination program. Therefore in the subsequent rounds of vaccination only the newly hatched birds and those not previously vaccinated were covered.

Infectious bursal disease (IBD)

A total of 246 serum samples from local chickens flocks in Dar es Salaam, Coast, Arusha and Singida Regions were tested for specific antibodies to IBD/ Gumboro Disease by Enzyme-linked immunosorbent assays (ELISA) using a commercial kit FlockChek from Idexx Europe B.V., Koolhovenlaan 20, 1119 NE Schiphol-Rijk, The Netherlands (see Table I). Sera from locations other the zone I and II study areas were used because those from project sites were depleted after being sent to Netherlands. The instructions specified for their use by the manufacturer were followed carefully. The procedure was based on a standard indirect ELISA technique to determine the presence of antibody in serum. The substrate used was TMB. The conjugate was a commercial (goat) anti-chicken IgG monoclonal antibody labelled with horseradish peroxidase. Results of the assay were read photometrically using a standard ELISA reader (Titertek Multiskan Plus, Finland) at an absorbency wavelength of 620 nm. The latter was used after failing to secure the 650 nm filter that was recommended by the manufacturers.

Negative control mean (NCx) and positive control mean (PCx) were calculated and employed for determining the relative level of antibody in the samples to positive serum (S/P) ratio. End point titres were calculated using the formula: $\log_{10}$ Titer = 1.09($\log_{10}$S/P) + 3.36. Serum samples with titers greater than 396 were considered positive and indicated exposure to IBDV. Negative score was given to all samples with the reaction of less than 0.2 S/P ratio and there were to 214 (87%) of them.

Housing

Appropriate housing using locally available materials were designed. The farmers were taught about the optimal shelter, which would prevent disease spread and predation. Using them entailed provision of feeds and water, which for the second time proved very diffficult. Instead, the farmers were advised to adopt the weaver basket in which only the chicks were kept during feeding. Supplementary feeding was advocated using layers mash feeds to augment availability of energy and protein. The supplementary feeds were not meant to meet all nutritional needs but only about one third of total needs per chicken, except for brooding hens and the chicks. Chicks were to be fed on chick mash and the hens; layers mash and these were supposed to be supplied *ad libitum* during the first one-month following hatching.

Partial Budgeting

Population dynamics of the flocks and the average price for adults and/or growers along with the cost of the interventions were determined. This was used as a basic database for the partial budget determinations for verifying whether the interventions were economically feasible.

RESULTS

Fowl pox vaccination

The fowl pox vaccine was effective in preventing Fowl Pox outbreaks. A small nodular swelling appearing seven days after vaccination, indicated successful immunization. The major problems encountered were those related to cold chain provision and the fact that the vaccine is dispensed in large quantities not suited to the needs of individual families or villages.

Realising the health problems posed by Fowl pox following ND control, ADRI initiated a research project aiming at developing a local vaccine. Several strains of avian pox virus were isolated from local chickens, commercial chickens, turkeys, guinea fowl and pigeons. Candidate vaccinal strains have been identified after carry out multiple passages and determination of antigenic properties and they are now being tested in a controlled experiment to determine safety and efficacy. Future plans are to determine their genetic properties using molecular biological techniques.

IBD serological testing

Serological results for 246 samples analysed for IBD are summarized in Table II and revealed a prevalence of approximately 2.85% (7/246).

TABLE II. SUMMARY OF RESULTS OF SEROLOGICAL SCREENING OF TANZANIAN LOCAL CHICKENS FOR IBD USING INDIRECT ELISA TECHNIQUE.

Location	N tested	Positive/total (%)	Negative/total (%)
Coast (Mafia)	128	6/128 (4.7)	122/128 (95.3)
Arusha (Arumeru)	93	1/93 (1.1)	92/93 (99.9)
Singida	4	0/4 (0)	4/4 (100)
Dar es salaam (Mmbande)	8	0/8 (0)	8/8 (100)
Dar es salaam (Tuangoma)	13	0/13 (0)	13/13 (100)
Total	246	0/246 (2.85)	0/246 (87)

Housing

The feeds were too expensive for the resource poor farmers and when provided were of inappropriate quality and therefore chicks died of deficiency syndromes. This intervention proved very difficult to implement.

Partial Budgeting

Income minus costs (profit) was calculated at Tshs. 2,094,000.00 (US $ 2326) income divided by costs (return) was 2.5 (Annex I). Given that the mathematical expression of both the profit and the return was greater than one, the vaccination intervention could be considered to have been successful

TABLE III. POPULATION DYNAMICS OF THE FLOCKS IN THE INVESTIGATED HOUSEHOLDS BELONGING TO SIX VILLAGES AND NUMBERS OF CHICKEN'S SOLD/GIVEN AS GIFTS, DIED/LOST OR CONSUMED IN THE PERIOD NOVEMBER TO FEBRUARY.

Village	Flock Size	No. of chickens Sold/Given as Gifts	No. of chickens Slaughtered	No. of chickens Dead Lost
Mwendapole	264	25	31	124
Pangani	261	37	71	113
Boko Timiza	451	50	22	93
Tuangoma	66	5	4	28
Mmbande	134	29	13	164
Gezaulole	81	0	0	0
Total	1257	146	141	522

TABLE IV. FLOCK SIZE AND STRUCTURE IN THE 43 FARMERS INTERVIEWED IN THE TWO ZONES DURING 2001. THE NUMBER IN THE PARENTHESIS DENOTES THE TOTAL NUMBERS ESTABLISHED IN THE BASELINE SURVEY IN 1999.

	Flock Size and structure				
	Total	Cocks	Hens	Growers	Chicks
February	1257	129	282	356	490
June	1295	121	296	325	553
October	1218	99	294	279	536
Average	(1099) 1256.7	(91) 116.3	(355) 290.7	(327) 320.0	(326) 526.3

TABLE V. DATA COLLECTED FROM 43 HOUSEHOLDS FOR CALCULATION OF INCOME GENERATED FROM THE NEWCASTLE VACCINATION PROGRAMME. (FEBRUARY 2001)

	Total	Cocks	Hens	Growers	Chicks
Flock Size and structure	1257 1295[a] 1218[b]	129 121[a] 99[b]	282 296[a] 294[b]	356 325[a] 279[b]	490 553[a] 536[b]
Sold/Given as Gifts	146 274[a] 94[b]	82 160[a] 49[b]	45 80[a] 44[b]	15 11[a] 1[b]	4 23[a] 0[b]
Dead/Lost birds	522 113[a] 35[b]	170 43[a] 48[b]	34 68[a] 44[b]	67 244[a] 399[b]	251 63[a] 28[b]
Slaughtered	141 73[a] 41[b]	102 71[a] 41[b]	30 2[a] 0[b]	9 0[a] 0 [b]	0 0[a] 0[b]

Key [a] and [b] denotes the corresponding Figures for the quarters ending in June and October respectively

Annex I

Partial Budgeting Form

Name of Country: Tanzania Date: 2001/2002

INCREASED INCOME		INCREASED COSTS	
Additional Income generated from the programme		Costs as a result of the programme	Tshs.
Adult and growers sold after the programme was started x price/unit	2307 x 2000	Training Extension Officers	200,000
		Training Manuals	20,000
		Backstopping visits	200,000
	Tshs. 4,614,000 (US $ 5126)	Implementation of vaccination and distribution and supply of vaccine	
		Cost of Newcastle disease vaccine	
MINUS		Fuel (Transport)	
		Allowances for FOs and	20,000
		VEOs during campaigns	200,000
			200,000
Adult and growers sold before the programme was started x price/unit	840 x 2000 Tshs. 1,680,000 ($ 1867)	Total Costs	Tshs. 840,000 ($ 933)
Difference in Income	Tshs. 2,934,000		($ 2326)
Income minus Costs (profit)		2,094,000 Tshs	
Income divided by Costs (return)		2.5	

DISCUSSIONS AND CONCLUSIONS

Besides ND, the other disease documented to limit local chicken productivity included fowl pox, coryza infections, fowl typhoid, Infectious Bursal Disease/Gumboro Disease and parasitic diseases (helminthosis, external parasitism, protozoan diseases). Diseases are the number one causes of chicken losses in form of deaths or mortality. The importance of detecting and controlling the diseases cannot be overemphasized. Fowl pox may occur in cutaneous form when it produces dramatic and prominent nodular lesions on the combs, wattles, but especially around the eyes on the eyelids, nostril and in the oral cavity. Although mortality is low, the disease causes indirect losses in terms of loss of weight. The diphtheritic form of fowl pox causes lesions in the GIT and respiratory tracts causing difficulties in feeding and breathing and then death. Fowl pox is prevalent among village chickens in Tanzania and hence control by vaccination was important. Unreported observations seem to indicate seasonal occurrence of fowl pox among village chickens especially around the rainy season. Fowl pox particularly proved a nuisance following ND control. The fact that pox lesions were manifested on the head – around the eyes, led to some farmers to connect the I-2 instilled by eye-drop method with this dreadful disease. It was therefore important to deal with this condition so as to strengthen the farmer's confidence in the use of I-2 vaccine.

Occurrence of clinical syndromes of infectious bursal disease (IBD) of chickens in Tanzania was first observed in 1989. The disease was encountered in layer chicks purchased from one commercial hatchery in Dar es Salaam (Kapaga *et al.,* 1989). Since this eruption, IBD in Tanzania has been occurring almost annually; the disease now being the main killer of intensively managed commercial layers in the major cities especially Dar es Salaam and Arusha. The disease syndrome has also been observed in scavenging chickens in some parts of rural Tanzania (Yongolo et al 1995).

Diagnosis of IBD in Tanzania has been based predominantly on pathological lesions seen at autopsy. Laboratory diagnostic procedures e.g. virus isolation and characterization as well as serological tests have not been established fully at any of the diagnostic laboratories in Tanzania, mainly due to lack of resources. The epidemiological patterns of IBD in Tanzania have for similar reasons not been precisely explored.

The study has shown that given the conditions that exist in the villages, use of thermostable I-2 vaccine administered by the eye-drop method once every three months will protect the local chickens against ND infection (2 weeks after vaccination, 91.3% of chickens had sero-converted with peak mean titre of greater than $\log_2 7$ and the mean peak titres remained at least $\log_2 3$ for 15 weeks after vaccination). The I-2 vaccine proved to be reliable (efficacy was computed at 79%). and easy-to-use for most people.

A standardised ELISA technique for both Newcastle disease and Gumboro disease has been established at the ADRI, which enhances the institute's Laboratory diagnostic capability.

The socio-economic data was used to compute partial budget whereby the profit was calculated at 81% and household income was 5.3 times returns on investment.

When titration of NDV antibodies using an ELISA test was done in 80 of the HI tested sera, the results showed that the relative sensitivity of ELISA to HI was 83.78; the relative specificity was 0/6; the Predictive value of a positive result was 91.17. If the cut-off value was changed from 30% (recommended by IAEA) to 15% then the relative sensitivity and the predictive value for a positive result for ELISA compared to HI could be improved to 95.94 and 92.2 respectively.

The prevalence study showed that about 2.85%of avian serum samples from local chickens examined by ELISA technique had positive results for IBDV.

Other related activities performed during this reporting period

Southern Africa Newcastle Disease Control Project (SANDCP)

The Southern Africa Newcastle Disease Control Project (SANDCP) is a three-year project financed by the Australian Agency for International Development that is supporting the control of ND in Mozambique, Tanzania and Malawi. The project started its activities in Tanzania in 2003.

The main purpose of SANDCP is to assist the Governments of Mozambique, Malawi and Tanzania to develop and implement efficient and equitable ND control programmes to improve smallholder, community and national welfare.The SANDCP aims to promote the vaccination of village chickens against ND using I-2 vaccine The project will work towards: Strengthening the capability of, and relationship between, stakeholders in order to successfully implement Newcastle disease (ND) control programmes, Achieving a decrease in chicken mortality rates caused by ND in project activity areas.

Technology Implementation Plan

The exploitable outputs of the project are: novel technique for controlling ND using I-2 vaccination has been achieved. Use of ELISAs for the detection of NDV and IBDV antigens has been established.

Several factors inhibiting rural chicken development were identified and possible solutions determined and tested.

Partial budget determinations were utilised to determine the economic feasibility of ND vaccination and high rates of return obtained.

These outputs have been, and shall continue to be disseminated in the following ways: presentations at national and international scientific meetings and conferences, publications in international peer-reviewed scientific journals, direct liaison during and after the project with national and regional ND control programmes operating in Tanzania, for example the SANDCP & Family poultry action Group (FAPIAG).

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SUMMARY OF FIVE YEARS OF IAEA FUNDED PROJECT ON IMPROVEMENT OF FAMILY POULTRY PRODUCTION IN AFRICA: RESULTS AND DISCUSSIONS*

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Abstract

During the period of February 1999 and April 2004, a study was undertaken to elucidate the major disease conditions and factors limiting family chicken production in Tanzania. It covered six villages in two zones involving 43 households from which socio-economic data was gathered by use of a structured questionnaire in the wet and dry seasons. During field visits, the birds were clinically examined, various samples collected, sick and dead ones autopsied. There was significant variation in the flock size and structure in the interviewed households. The households kept a total of 1099 and 1352 chickens with an average of 25.5 and 31.4 per household in the wet and dry seasons respectively. The ratio of chick/growers/ adults was 10:10:14 and 11:10:10 in wet and dry seasons respectively. The cocks/hen ratio was 1:3.5. Whereas the average number of clutches per year was 3, the number of eggs per clutch was 12 and therefore the number of eggs was 36 per hen/year. Average hatchability for the two seasons was recorded as 84%. Chick mortality was found to be 30% and resulted mainly from diseases and predation. Only few households did not provide housing at all while majority provided shelters of varying quality. In all the households, scavenging was the system of feeding and sometimes supplemented by household food scraps and local feeds. Several diseases and in particular Newcastle disease (ND) was shown to be the major constraint inhibiting rural chicken development. Women played a major role in family poultry production through provision of labour but men made several decisions on the use of the resources. Blood smears were prepared for protozoological examination: 349 (wet season), 278 (dry season).

Only 11 of the 349 (3.1%) birds in the wet season were infected with Leucocytozoon simondi and Haemoproteus columbae (prevalence 2.8% and 0.3%, respectively). No parasites were seen in the samples collected during the dry season. Fresh faecal samples (209) in the wet season and dry season were collected and examined for egg worm count using the McMaster technique. The cross sectional prevalence study showed that about 77% of faecal samples examined had positive results for helminths. Eight different species of helminths eggs were identified. During the dry season, serum samples were collected from a total of 362 ND unvaccinated birds and analysed by haemagglutination inhibition (HI) test for ND virus antibodies. The results indicated that only 56 (15.5%) birds had positive HI titres at a serum dilution of 1:8 and above while 306 (85.5%) birds were negative. A serologically monitored ND vaccination exercise using thermostable vaccine strain I-2 was undertaken. The results of HI and ELISA tests indicated that vaccinations had been very effective. Population dynamics of the flocks were determined on a monthly basis along with the cost of the interventions. This was used as a basic database for the partial budget determination. Profit was calculated at 81% and the return of investment was 2.5 and hence the vaccination intervention was successful.

INTRODUCTION

In Tanzania, good statistics on the Poultry population are not available but the total number is believed to be on the order of 30,900,000 chickens (1994/95 National Sample Census of Agriculture report volume II). Within this number are found the following: 26,400,000 are the local village chickens kept predominantly in the rural areas. Commercial birds include broiler and layer chickens estimated to be about 3,200,000 at any one time or a turnover of 20 million total commercial chickens per year. There are 1,200,000 ducks and geese, 90,000 turkeys and 40,000 guinea fowls. Other types of poultry kept include pigeons. It is estimated that out of 3,700,000 total agricultural households, the majority (72%) reaching 2,500,000 households keep chickens compared to 1.10 million, 1.30 million and 520,000 that keep cattle, goats and sheep respectively.

The population of rural chicken fluctuates widely from season to season mainly due to the periodic occurrence of Newcastle disease. Other losses result from predators and management factors (such as nutrition/feeding, housing etc.). Of all the livestock kept in Tanzania, local chickens are the most widely evenly distributed throughout the country (Boki, 2000). However, a large portion of the national total is found in Lake Zone and Southern highlands and especially in Mbeya, Shinyanga and Iringa. In Southern regions particularly Mtwara, the role of family chicken as a commodity is higher than anywhere else in the country due to low numbers or total absence of other livestock. The major farmyard management system is free ranging (scavengers) with a small shelter. There are several advantages of the traditional poultry husbandry system that includes: absence of religious objections for the consumption of poultry, both poultry meat and the eggs contain protein of a high biological value, women and children are often in charge of the farmyard poultry thereby getting an opportunity to uplift themselves and earning an income. The production of poultry is a relatively efficient and fast way to turn raw and waste materials into valuable animal protein: poultry has a high feed conversion compared to other livestock, no cold chain is needed; the birds can be bought alive, Poultry litter is a very efficient fertilizer, farmers are, in principle, more willing to sell poultry and their products rather than the larger livestock. Poultry represent a regular cash flow, whereas ruminants represent more of a capital reserve. Other uses of local chickens in Tanzania are: To meet 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 children illnesses, female infertilities, abnormally prolonged menstrual periods; and simple fractures. Local chickens play an important role in social life in villages during ceremonies, rituals, in traditional healing and gifts to respectable guests

Large markets for rural chickens are found in urban centres. In order to exploit urban markets, traders have to transport live local birds for long distances using large wicker baskets on trucks and on roof-tops of buses from centres of production in central zones (Dodoma and Singida) to centres of consumption particularly Dar es Salaam. Singida region is probably the only area where local chicken keeping has assumed a serious business outlook.

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). Per capital consumption of chicken products in Tanzania is very low at 1.07 Kg (c.f. 6.8) of meat and 9.4 (c.f. 108) eggs. It is generally accepted that the taste of village chicken is superior to the commercial broiler and layers and therefore the former fetches a higher market price than the exotics. Large markets for rural chickens are found in urban centres. In order to exploit urban markets, traders have to transport live local birds for long distances using large wicker baskets on trucks and on roof-tops of buses from centres of production in central zones (Dodoma and Singida) to centres of consumption particularly Dar es Salaam. Singida region is probably the only area where local chicken keeping has assumed a serious business outlook.

Many international organisations, animal scientists and veterinarians are now becoming interested in the potential productivity of village chickens. The causes of low productivity are being defined and suitable interventions are being designed. Under the auspices of International Atomic Energy Agency (IAEA), a research project on family poultry was conducted from March 1999 to April 2004, to try and identify the major disease conditions and factors limiting family chicken production in Coast and Dar es Salaam regions of Tanzania. Newcastle disease was revealed to be the major constraint inhibiting rural chicken development followed closely by poor housing that causes high chick mortality through diseases and predation. Therefore subsequent interventions directed towards these major limitations of rural chicken production were planned and implemented. The project reported here sought to address the issue through specific scientific objectives.

The main objective of the project was to increase poultry production, both the meat and egg production, and to decrease medication costs of the small holder poultry farmer by controlling the most important contagious diseases through the development of sound locally applicable vaccination strategies using nuclear related techniques. The overall objective of this project in Tanzania was to improve village poultry production through the introduction of cost effective and sustainable interventions.

The specific objectives included: to identify the major disease conditions and factors limiting family chicken production in Tanzania, to control Newcastle disease through vaccination using heat stable I-2 vaccine by eye-drop inoculation, to reduce deaths of chicks through improvement of shelter, to assess the economic impact of the undertaken interventions.

MATERIALS AND METHODS

Selection of study areas

Study sites were selected in two regions of Tanzania: Two ecological zones in the coast (zone I) and Dar es Salaam region (zone II) of Eastern Tanzania were selected for the field study. The weather in the zones is characterised by marked seasonality: dry season (June–October, January–March) and rainy seasons {March–May (long rains), November–December, (short rains)}. Field visits were centred on three villages (Mwendapole, Pangani, Boko) in Kibaha district (in zone I) and three others (Toangoma, Mbande and Gezaulole) in Temeke district (in zone II). With the assistance of Government & Livestock Field Officers responsible for the respective villages, 6–11 farmers preferably female who keep family chicken were identified from each village. Visits were then made to the respective village for the purpose of explaining the objectives of the research project to the village leadership, villagers and particularly so to the participants of the project. The latter were notified of specific dates when they will be visited for data and sample collections during the wet and dry seasons.

The Field Study Areas were selected and baseline data and samples were collected during wet and dry seasons of 1999/2000. The dataset included farmer interviews in the selected villages by use of structured questionnaire to gather information on productivity parameters, husbandry practices, flock ownership pattern and labour profiles. The results were presented in detail at the 2nd RCM meeting in Morogoro Tanzania (Msami, 2000)

Field activities

The field activities were: sensitisation of local communities to the project activities, and notification of poultry keepers of the dates of sampling visits by Animal Diseases Research Institute (ADRI) field teams; examination of chickens for any sign of disease or parasites; thorough autopsy on 27 sick or dead birds; collection of background epidemiological data; preparation of thick and thin blood smears; blood collection from adult and growing birds by puncture of the wing vein; administration of socio-economic questionnaires on poultry keeping and husbandry practices; recording of all field information on standard data sheets; vaccination against ND and Fowl pox; poultry population dynamics recording; design of shelter through PRA techniques; procurement of feeds; collection of fresh faecal samples.

Laboratory activities

These included: recording all information from field sheets and from laboratory tests in PC databases, thick and thin blood smears stained and examined protozoologically for haemoparasites: 349 (wet season), 278 (dry season), after coagulation, sera were harvested, in cryotubes and preserved at –20°C until used for testing of specific antibodies to ND virus (NDV) using the haemaglutination inhibition (HI) test and ELISA test to detect antibodies against ND and IBD, statistical analysis of project data, faecal samples examined for egg worm count through McMaster technique (209 samples in the wet season and 211 samples in the dry season)

RESULTS

There was significant variation in the flock size and structure in the interviewed households. The 43 households kept 1099 and 1352 chickens with an average of 25.5 and 31.4 per household in the wet and dry seasons respectively. The ratio of chick/growers/adults was 10:10:14 and 11:10:10 in wet and dry seasons respectively. The cocks/hen ratio was 1:3.5. Average numbers of clutches per year ranged from 2.80–3.02 (average 2.94) in the wet season and 3.0–3.36 (average 3.16) in the dry season. Average number of eggs per clutch was 12 and therefore the number of eggs was 36 per hen/year. Average hatchability for the two seasons was recorded as 84%. Chick mortality was found to be 30% and resulted mainly from diseases and predation. Out of 43 households interviewed 23 kept their chickens in the chicken house, 12 within the family house, 4 in the kitchen/store, 3 kept their birds perched in trees and 1 in woven basket. The corresponding figures for the dry season were 22, 12, 3, and 2. In all the households, scavenging was the system of feeding and sometimes supplemented by household food scraps and other local feeds e.g. maize bran. Several diseases and in particular Newcastle disease was mentioned by farmers in both zones as the major constraint inhibiting rural chicken development. Other diseases included coughing/sneezing, fowl pox and parasitic diseases (helminths, external parasitism, protozoa). Women played a major role in family poultry development through provision of labour but men made decisions on the use of the resources.

Blood smears were prepared for protozoological examination: 349 (wet season), 278 (dry season). Only 11 of the 349 (3.1%) birds in the wet season were infected with *Leucocytozoon simondi* and *Haemoproteus columbae* (prevalence 2.8% and 0.3%, respectively). A large number of fresh faecal samples (209) were collected during the wet and the dry season from poultry in the 43 homesteads. They were examined for egg per gram (EPG) faeces by the McMaster technique. The cross sectional prevalence study showed that 77% of 209 faecal samples examined had positive results for helminths. Eight different species of helminths eggs were identified.

The details of these findings were presented at the 2nd Research Coordination Meeting of the Coordinated Research Project that was held at Morogoro, Tanzania, from 4 to 8

September, 2000 (Msami, 2000). These were discussed in detail and on the basis of the discussions; the work programme for the following year of the project, 2001–2 was formulated.

Work done 2001–2

From the previous survey results, several management factors, and diseases and in particular, Newcastle disease were established in both zones as the major constraint affecting rural chicken development. (Msami 2000). It followed therefore that in order to improve family poultry production in Tanzania the control of Newcastle disease through vaccination using heat stable I-2 vaccine by eye-drop inoculation should be undertaken. In addition, housing needed to be improved to assist in disease control and in particular combat predation, which had been identified as the major cause of chick mortality.

Field visits continued in the three villages (Mwendapole, Pangani, Boko) in Kibaha district in zone I and three others (Toangoma, Mbande and Gezaulole) in Temeke district in zone II.

During the dry season, serum samples were collected from a total of 362 unvaccinated birds and analysed by haemagglutination inhibition (HI) test for ND virus antibodies. The results indicated that only 56 (15.5%) birds had protective HI titres at a serum dilution of 1:8 ($\log_2 3$) and above while 306 (85.5%) birds were not protected. A serologically monitored ND vaccination exercise using thermostable vaccine strain I-2 locally produced at ADRI was undertaken. Following this, serum samples were collected in two phases: 252 two weeks post vaccination and 285 fifteen weeks post vaccination and similarly analysed. The results indicated that vaccinations had been very effective. Vaccinated flocks showed peak mean titres of greater than $\log_2 7$ two weeks after vaccination; the mean peak titres remained at least $\log_2 3$ for 15 weeks after vaccination. No ND outbreak was experienced in the vaccinated flocks during the observation period. The high titres found in some chickens before vaccination most likely resulted from natural outbreaks of ND. Titration of antibodies using an ELISA test was also done in 80 of the HI tested sera. The relative sensitivity of ELISA to HI was 83.8; and the predictive value of a positive result was 91.2.

PRA was undertaken for the purpose of designing appropriate housing, specifically for chicks, using locally available materials and use of wicker basket popularly known as "tenga" was adopted. The vaccinated chickens on eight farms were to be used as a control group. The other 35 farms were to be used for a housing intervention. Once the birds were housed, they needed to be fed and provided with water and initially the farmers agreed to the idea of providing the feeds. However, procurement of feeds for the housed birds proved difficult, farmers let their birds free, and assessment of this intervention could not be done.

Population dynamics of the flocks and the average price for adults and/or growers along with the cost of the interventions were determined. This was used as a basic database for the partial budget determinations for verifying whether the interventions were economically feasible. Income minus costs (profit) was calculated at Tshs. 2,094,000.00 (US $ 2326) income divided by costs (return) was 2.5 (Annex I). Given that the mathematical expression of both the profit and the return was greater than one, the vaccination intervention could be considered to have been successful

The details of these findings were presented at the 3rd Research Coordination Meeting of the Coordinated Research Project that was conducted at Quatre Bornes, Mauritius, 6–10

May 2002. (Msami 2002). These were discussed in detail and on the basis of the discussions; the work programme for the final year of the project, 2003–4 was formulated

Work done 2003–4

The work undertaken in the final 18 months of the project aimed at fulfilling the following specific objectives:

- To continue with the control of Newcastle disease through vaccination using heat stable I-2 vaccine by eye-drop inoculation so as to ensure survival of birds in ND outbreaks.
- To reduce deaths of chicks through improvement of Fowl pox control. With the control of ND, several other diseases have surfaced demanding an attention previously unwarranted.
- To reduce deaths of chicks through improvement of shelter for chicks. The low number of growers and chicks noted in the previous survey was mainly due to high chick mortality (that reached over 30%) resulting from diseases, predation and nutritional disorders. Housing for the chicks needed to be improved to assist in disease control and in particular the predation.
- To test the frozen sera collected in the previous survey and preserved at ADRI for specific antibodies to Infectious Bursal Disease (IBD)/ Gumboro Disease by Enzyme-linked immunosorbent assay (ELISA) technique.

Field visits continued in the three villages (Mwendapole, Pangani, Boko from Kibaha in zone I and three others (Toangoma, Mmbande and Gezaulole) from Temeke District in Zone II selected earlier in the survey work. Use of the already engaged Government and Livestock Field Officers responsible for the respective 6 villages was made.

The 43 households from the 6 villages were used for ND vaccination as the experimental units. The non-vaccinated households in the neighbourhood were considered as controls. Initial visits were made to the villages for sensitisation on the importance of the intended interventions. They were notified of the vaccination and sample collection dates. In total 16 visits were made. All the 1352 chickens identified during the surveys and newly hatched chicks belonging to the 43 households were vaccinated through the eye drop route using thermo stable vaccine I-2 strain locally produced at ADRI. 3 Vaccinations at intervals of 4 months were conducted during the months of February, June and October. These periods are now the accepted vaccination calendar in the involved villages.

Fowl pox

Besides ND, the other disease documented to limit local chicken productivity included fowl pox, infections coryza, fowl typhoid, Infectious Bursal Disease/Gumboro Disease and parasitic diseases (helminthosis, external parasitism, protozoan diseases). Diseases are the number one causes of chicken losses in form of deaths or mortality. The importance of detecting and controlling the diseases cannot be overemphasized. Fowl pox may occur in cutaneous form when it produces dramatic and prominent nodular lesions on the combs, wattles, but especially around the eyes on the eyelids, nostril and in the oral cavity. Although mortality is low, the disease causes indirect losses in terms of loss of weight. The diphtheritic form of fowl pox causes lesions in the GIT and respiratory tracts causing difficulties in feeding and breathing and then death. Fowl pox is prevalent among village chickens in

Tanzania and hence control by vaccination was important. Unreported observations seem to indicate seasonal occurrence of fowl pox among village chickens especially around the rainy season. Fowl pox particularly proved a nuisance following ND control. The fact that pox lesions were manifested on the head, around the eyes, led to some farmers to connect the I-2 instilled by eye-drop method with this dreadful disease. It was therefore important to deal with this condition so as to strengthen the farmer's confidence in the use of I-2 vaccine. A commercial vaccine from Shafit Biological Laboratories Israel was used for controlling the disease. The vaccine was reconstituted by transferring 5 ml of diluent into the freeze-dried vaccine before it was applied by dipping the needle in the vaccine suspension and stabbing through the underside skin of the wing web or the skin of the thigh. Each bird was vaccinated only once, preferably during the first round of I-2 ND vaccination programme. Therefore in the subsequent rounds of vaccination only the newly hatched birds and those not previously vaccinated were covered.

Housing

Appropriate housing using locally available materials were designed. The farmers were taught about the optimal shelter, which would prevent disease spread and predation. Using them entailed provision of feeds and water, which for the second time proved very difficult. Instead, the farmers were advised to adopt the weaver basket in which only the chicks were kept during feeding. Supplementary feeding was advocated using layers mash feeds to augment availability of energy and protein. The supplementary feeds were not meant to meet all nutritional needs but only about one third of total needs per chicken, except for brooding hens and the chicks. Chicks were to be fed on chick mash and the hens; layers mash and these were supposed to be supplied *ad libitum* during the first one-month following hatching. The feeds were too expensive for the resource poor farmers and when provided were of inappropriate quality and therefore chicks died of deficiency syndromes. This intervention proved very difficult to implement.

Infectious bursal disease (IBD)

Occurrence of clinical syndromes of infectious bursal disease (IBD) of chickens in Tanzania was first observed in 1989. The disease was encountered in layer chicks purchased from one commercial hatchery in Dar es Salaam (Kapaga *et al.,* 1989). Since this eruption, IBD in Tanzania has been occurring almost annually; the disease now being the main killer of intensively managed commercial layers in the major cities especially Dar es Salaam and Arusha. The disease syndrome has also been observed in scavenging chickens in some parts of rural Tanzania (Yongolo et al 1995).

Diagnosis of IBD in Tanzania has been based predominantly on pathological lesions seen at autopsy. Laboratory diagnostic procedures e.g. virus isolation and characterization as well as serological tests have not been established fully at any of the diagnostic laboratories in Tanzania, mainly due to lack of resources. The epidemiological patterns of IBD in Tanzania have for similar reasons not been precisely explored.

A total of 246 serum samples from local chickens flocks in Dar es Salaam, Coast, Arusha and Singida Regions were tested for specific antibodies to IBD/ Gumboro Disease by Enzyme-linked immunosorbent assays (ELISA) using a commercial kit FlockChek from Idexx Europe B.V., Koolhovenlaan 20, 1119 NE Schiphol-Rijk, The Netherlands (see Table I). Sera from locations other the zone I and II study areas were used because those from project sites were depleted after being sent to Netherlands. The instructions specified for their use by the manufacturer were followed carefully. The procedure was based on a standard indirect ELISA technique to determine the presence of antibody in serum. The substrate used was TMB. The conjugate was a commercial (goat) anti-chicken IgG monoclonal antibody labelled with horseradish peroxidase. Results of the assay were read photometrically using a standard ELISA reader (Titertek Multiskan Plus Finland) at an absorbency wavelength of 620 nm. The latter was used after failing to secure the 650 nm filter that was recommended by the manufacturers.

Negative control mean (NCx) and positive control mean (PCx) were calculated and employed for determining the relative level of antibody in the samples to positive serum (S/P) ratio. End point titres were calculated using the formula: $\log_{10}$ Titer = 1.09($\log_{10}$S/P) + 3.36. Serum samples with titers greater than 396 were considered positive and indicated exposure to IBDV. Negative score was given to all samples with the reaction of less than 0.2 S/P ratio and there were to 214 (87%) of them.

RESULTS

Fowl pox vaccination and IBD serological testing

The fowl pox vaccine was effective in preventing Fowl Pox outbreaks. A small nodular swelling appearing seven days after vaccination, indicated successful immunization. The major problems encountered were those related to cold chain provision and the fact that the vaccine is dispensed in large quantities not suited to the needs of individual families or villages.

Realising the health problems posed by Fowl pox following ND control, ADRI initiated a research project aiming at developing a local vaccine. Several strains of avian pox virus were isolated from local chickens, commercial chickens, turkeys, guinea fowl and pigeons. Candidate vaccinal strains have been identified after carry out multiple passages and determination of antigenic properties and they are now being tested in a controlled experiment to determine safety and efficacy. Future plans are to determine their genetic properties using molecular biological techniques.

Serological results for 246 samples analysed for IBD are summarized in Table I and revealed a prevalence of approximately 2.85% (7/246).

TABLE I. SUMMARY OF RESULTS OF SEROLOGICAL SCREENING OF TANZANIAN CHICKENS FOR IBD USING INDIRECT ELISA TECHNIQUE.

Location	Number tested	Positive/total number (%)	Negative/total number (%)
Coast (Mafia)	128	6/128 (4.7)	122/128 (95.3)
Arusha (Arumeru)	93	1/93 (1.1)	92/93 (99.9)
Singida	4	0/4 (0)	4/4 (100)
Dar es salaam (Mmbande)	8	0/8 (0)	8/8 (100)
Dar es salaam (Tuangoma)	13	0/13 (0)	13/13 (100)
Totals	246	7/246 (2.85)	239/246 (97)

Other related Activities Performed during this reporting period

Southern Africa Newcastle Disease Control Project (SANDCP)

The Southern Africa Newcastle Disease Control Project (SANDCP) is a three-year project financed by the Australian Agency for International Development that is supporting the control of ND in Mozambique, Tanzania and Malawi. The project started its activities in Tanzania in 2003.

The main purpose of SANDCP is to assist the Governments of Mozambique, Malawi and Tanzania to develop and implement efficient and equitable ND control programmes to improve smallholder, community and national welfare.The SANDCP aims to promote the vaccination of village chickens against ND using I-2 vaccine.The project will work towards:

- Strengthening the capability of, and relationship between, stakeholders in order to successfully implement Newcastle disease (ND) control programmesAchieving a decrease in chicken mortality rates caused by ND in project activity areas.

CONCLUSIONS

- The project may be considered to be an outstanding success in that a major contribution has been made to the understanding of several constraints hindering family poultry production in Eastern Tanzania and Tanzania as a whole. In order to increase productivity from family poultry therefore, these factors must be addressed at least in stages.
- Flock size and structure varied widely from 1099 chickens (average of 25.5) per household in wet season and 1352 (average 31.4) in the dry season. The ratio of chick: growers: adults was 10:10:14 in the wet season and 11:10:10 in the dry season. The cocks: hen ratio was 1:3.5.
- Average numbers of clutches per year ranged from 2.80 to 3.02 (average 2–94). Average number of eggs per clutch was 12 and therefore number of eggs was 36 per hen/year.
- Hatchability was recorded to be 84.5.and chick mortality was found to be 30% and resulted mainly from diseases and predation.
- Most of households provided housing to their birds and scavenging was the system of feeding with limited supplementation by household scraps and other feeds.
- Newcastle disease was found to be the major constraint inhibiting rural chicken development. Other diseases included respiratory syndromes, fowl pox and parasitic diseases (helminths, external parasitism, protozoa). It is recommended that control of ND in village chickens should be accompanied with Fowl pox control programme
- The study has shown that given the conditions that exist in the villages, use of thermostable I-2 vaccine administered by the eye-drop method once every three months will protect the local chickens against ND infection (2 weeks after vaccination, 91.3% of chickens had seroconverted with peak mean titre of greater than log2 7 and the mean peak titres remained at least log2 3 for 15 weeks after vaccination). The I-2 vaccine proved to be reliable (efficacy was computed at 79%). and easy-to-use for most people.

- Women played a major role in family poultry development through provision of labour but men made the decisions on the use of the resources.
- A standardised ELISA technique for both Newcastle disease and Gumboro disease has been established at the ADRI, which enhances the institute's Laboratory diagnostic capability.
- The socio-economic data was used to compute partial budget whereby the profit was calculated at 81% and household income was 5.3 times returns on investment.
- When titration of NDV antibodies using an ELISA test was done in 80 of the HI tested sera, the results showed that the relative sensitivity of ELISA to HI was 83.78; the relative specificity was 0/6; the Predictive value of a positive result was 91.17. If the cut-off value was changed from 30% (recommended by IAEA) to 15% then the relative sensitivity and the predictive value for a positive result for ELISA compared to HI could be improved to 95.94 and 92.2 respectively.
- The prevalence study showed that about 2.85%of avian serum samples from local chickens examined by ELISA technique had positive results for IBDV.

Technology Implementation Plan

The exploitable outputs of the of the project are:

- novel techniques for controlling ND using I-2 vaccination has been achieved. Use of ELISAs for the detection of NDV and IBDV antigens have been established.
- Several factors inhibiting rural chicken development were identified and possible solutions determined and tested.
- Partial budget determinations were utilised to determine the economic feasibility of ND vaccination and high rates of return obtained

These outputs have been, and shall continue to be disseminated in the following ways:

- presentations at national and international scientific meetings and conferences
- publications in international peer-reviewed scientific journals
- direct liaison during and after the project with national and regional ND control programmes operating in Tanzania, for example the SANDCP & Family poultry action Group (FAPIAG).

Training

During the project, I attended a three-month (from 3rd September to 2nd December 2001) practical training supported by International Atomic Energy Agency on "Laboratory aspects of the production of I-2 thermostable Newcastle disease vaccine" at the School of Veterinary Science University of Queensland Brisbane Australia. Also I was facilitated to attend an International Symposium on Applications of Gene-based Technologies for Improving Animal Production and Health in Developing Countries held in Vienna, Austria from October 6–10, 2003.

Scientific exchanges were made by scientific staff of IAEA to contract holders and between contract holders themselves. Dr. Ilango of the Uganda visited and provided assistance with fieldwork to the ADRI in October 2001. Dr.Karim Tounkara of the PACE Nairobi also visited and provided assistance with laboratory work to the ADRI, Dar-es-Salaam June 2001.

Papers presented at conferences

Msami, H.M. and A. M. Kapaga. (1999) Village Chickens In Tanzania: Situation Report Paper presented at the First Research Coordination Meeting of The FAO/IAEA Coordinated Research Programme On "Assessment of the Effectiveness of Vaccination Strategies Against Newcastle Disease and Gumboro Disease Using Immunoassay-based Technologies for Increasing Farmyard Poultry Production in Africa" Institut Agronomique et Veterinaire Hassan II, in Rabat, Morocco 8 to 12 February 1999

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