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# The impact of Newcastle disease control in village chickens on the welfare of rural households in Mozambique

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**Abstract.** To confirm that the control of ND in village chickens can make a significant contribution to poverty alleviation, the Southern Africa Newcastle Disease Control Project is measuring the impact of ND control on the welfare of participating farmers in two ways: firstly by developing a model that identifies the key issues and indicates the potential financial gain to farmers; and secondly by conducting annual baseline and PRA studies to monitor changes in chicken production and household welfare. Analysis and modelling indicated that control of ND alone has the potential to increase household income derived from chickens by 42%. Furthermore, when ND control is coupled with other initiatives, the model shows a potential increase in household income of 82% above pre-ND control levels. After the first year of the project, where ND vaccination campaigns were conducted by community vaccinators administering I-2 ND vaccine at four-monthly intervals, average village chicken flocks of participating farmers increased from 5 to 13 and home consumption and sale of both birds and eggs also increased.

## INTRODUCTION

Newcastle Disease (ND) is one of the most significant constraints to village chicken production in Mozambique [1, 2, 3, 4]. In many of the poorest rural households, chickens are the only livestock that the household owns, and are the main/only source of cash and/or savings for essentials and household emergencies [5]. They are generally owned and managed by women and children [6, 7]. Village chicken production has traditionally been under-rated in importance as a vehicle for rural development, due in many cases to the constraints that ND imposed on the development of this small scale industry.

In 1999, the Mozambican population was estimated to be 16 million (52% female and 48% male) with 71% living in rural areas [8]. In 2000, GDP per capita was estimated to be USD 210 [9]. Two thirds of Mozambicans live in absolute poverty, surviving on less than a quarter of one US dollar per day. It is estimated that 72% of the general population is illiterate. Illiteracy is higher among women (85%) [10].

Effective, low cost control of ND using appropriate technology has obvious benefits and the vaccine is being received by farmers with enthusiasm. To confirm that the control of ND in village chickens can make a significant contribution to poverty alleviation, the Southern Africa Newcastle Disease Control Project (SANDCP; a project implemented in Mozambique, Malawi and Tanzania with funding from the Australian Agency for International Development) is attempting to measure the impact of ND control on the welfare of participating farmers in two ways: firstly by developing a model that identifies the main issues and indicates the potential for financial gain to farmers; and secondly by conducting annual baseline and PRA studies to monitor changes in chicken production and household welfare.

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## VILLAGE CHICKEN PRODUCTION MODEL

To undertake an analysis of the impact of ND control on household welfare, it is necessary to compare the size, structure, productivity, turnoff and sales of representative flocks, before and after ND control is introduced. Furthermore, the impact of ND control can either be assessed in isolation, or it can be coupled with a range of other interventions/improvements which are likely to follow ND control. There is justification for including the benefits of other improvements that previously would not have been possible (or worth doing) because of the overwhelming impact of ND, provided that any additional production and capital costs are also included.

The model developed by SANDCP therefore has two components; ND control alone, and an "Improved Model" which incorporates additional changes such as improved hen productivity, improved husbandry and flock management, and further reductions in mortalities due to improved control of other diseases, specific measures to target chick mortalities and measures to combat predators and theft.

However, one of the difficulties is deciding how far this add-on process should be taken. For example, village poultry could be continuously improved with confinement, intensification, purchased feeds and new breeds until it became indistinguishable from the commercial industry. This is not the focus of SANDCP, and the authors believe that the interests of the rural poor would best be served by restricting innovation so as not to change the competitive advantage that village poultry has: i.e., the utilisation of a low quality feed resource at practically no cost. Thus changes have been restricted to those that can be achieved from within the household's own resources without adding any significant cash production or capital costs.

The SANDCP model indicates the type of analysis which needs to be done and the data required, the most important factors/interventions for success, and assists with development of extension material. The model is based on a 10 hen flock with typical pre-ND control structure and characteristics. The model uses data from the literature to represent a typical African flock prior to ND control [11, 12] and then assesses the impact of a series of possible changes.

The existing scavenging feed resource base (SFRB) is specifically included in the models as the major limiting factor. In line with the comments on the most appropriate development path outlined above, the use of purchased feeds or household crops (that could otherwise be sold or consumed) would be an inferior option in increasing welfare of the rural poor. Accordingly, the model focuses on maximising the output of the village flock from the current SFRB. The feed resource must be considered as probably the most significant constraint to expansion of flocks once ND is under control. Greater survival rates and improving hen productivity would obviously allow flock numbers to expand beyond the capacity of the SFRB. Fewer hens would be required, and/or fewer chicks raised for a given flock size, so that the pressure on the SFRB can be contained by reducing the number of hens (the meat model) or harvesting eggs (the egg model).

There have been numerous studies attempting to shed light on the quality and quantity of the SFRB. Sonaiya [13] states that "control of ND in scavenging chickens invariably results in greater need for supplementation", and suggests that there is an interaction between vaccination and supplementation in respect of mortalities.

Roberts [14] states that in general "the size of the SFRB in a village is limited, of low quality, and fully utilised. Village populations of scavenging chickens grow until the capacity of the SFRB is exceeded. The low protein content is inadequate for chicks and growers. Consequently the weaker chicks and growers die of starvation when there is competition for scavenging feed. Growth and survival rate of chicks are greatly improved if they can be given preferential access to household refuse supplemented with protein".

The control of ND enables the stabilisation of flock numbers and structure. As the SFRB is finite, the flock management challenge in a post-ND environment is to increase the productivity of hens so that fewer hens are required, which enables more chickens (or eggs) to be harvested from a given flock size. In other words, the task is to maximise the turnoff (or egg production) from a given SFRB, which requires careful management of flock size, structure and turnoff. The household impact will vary between agro-ecological zones, and the size of the household and its flock.

There are many examples in the literature of flock models which have been constructed for a variety of purposes; some are simple and some are highly complex, and attempt to simulate the dynamics of disease outbreaks, seasonality, the SFRB and so on. Such models are only as good as the data that is fed into them, and the more complicated they become the less confidence there is that there is adequate data to support the assumptions, and that the results actually mean something.

A simple static flock model was constructed, which is easily understood, and contains the most important variables likely to be influenced by, or relevant to, ND control. The purpose of the model is to simulate the impact of interventions, starting with ND control, and then progressing with the other low-cost improvements. In each case the output is the sale of eggs and/or chickens at market prices, making no distinction between home consumption or sale for cash.

**Model Assumptions**

***Pre-ND Flock Characteristics***

The pre-ND control flock parameters have been distilled from the literature to represent a typical African flock. Because there is such a wide range of flock sizes, the model is for a 10 hen flock, which can then be easily adapted to different flock sizes. The traditional system model is shown in Figure 1 below.

***Breeder Replacement***

It is assumed that both laying hens and cocks are replaced annually. In practice good layers may be retained longer than this.

***Valuation of Output***

Whether a bird or eggs are sold or consumed by the household, the contribution to household welfare and food security is the same, as the family has the choice to either sell or consume. For example a decision to consume a chicken could also be regarded as a decision to buy, as the chicken could have been sold for cash, and the family has decided to forego the cash in order to consume. It does not matter whether it is one of the household’s chickens that is consumed or whether it is purchased at the market, the result is essentially the same. Thus all birds or eggs produced are valued at market prices.

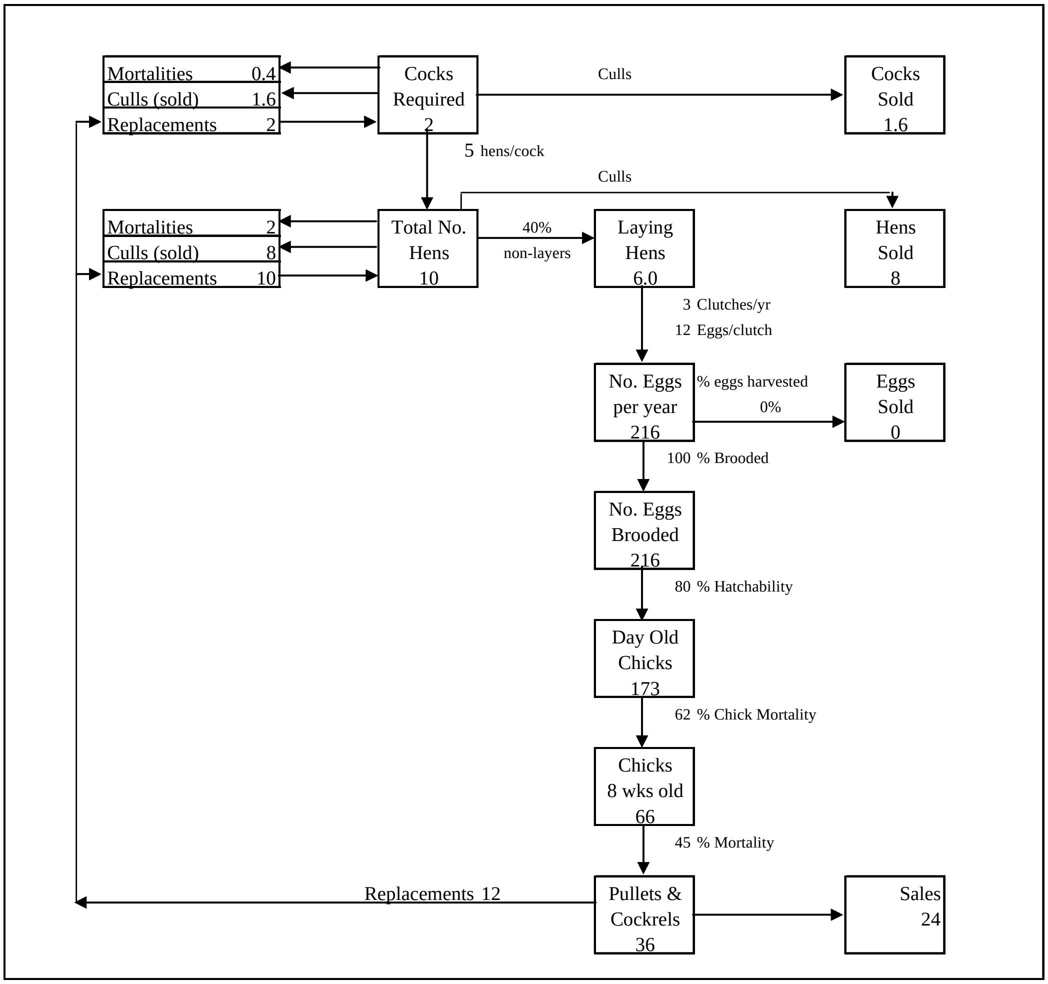


**Figure 1. Traditional System Flock Model – Before ND Control**

***Scavenging Feed Resource Base***

In testing the impact of new interventions, the SFRB is set as the overall limiting factor in the model for the reasons outlined earlier. With a fixed SFRB, the model requires that flock size be limited to the feed resource available, either by removing surplus eggs for sale, or by reducing hen numbers. Without ND control, farmers do not generally practise such flock management as the more chicks that are hatched the more likely that some would survive to maturity. Flock management will be a new experience for farmers as they learn how many chickens they can support with the feed resources available.

There are no data to enable the SFRB to be specified directly. Instead the SFRB is based on the number of “adult bird equivalents”. The concept of “adult bird equivalents” (ABE) has been borrowed from similar models for sheep and cattle where the grazing resource is the overall limiting factor, and stocking rates have to be adjusted so that the resource is not over grazed. Sonaiya et al [11] use a similar concept in chickens for the purpose of estimating the size of the SFRB, and refered to the number of “bird units relative to the cock”, based on average body weights of various classes of birds in the flock. Their estimation of bird units is presented in Table 1, and these numbers are also adopted for the flock model here, but will continue to be termed “adult bird equivalents”.

**Table 1: Estimation of bird units.**

| Class of bird | Average body weight (g) | Bird unit assigned |
|---|---|---|
| Cocks | 1039 | 1.0 |
| Hens | 873 | 0.8 |
| Growers | 458 | 0.4 |
| Chicks | 72 | 0.07 |

Source: [11]

The basic assumption in the model is that prior to ND control the SFRB is fully utilised, except that during periods when the flock is completely wiped out by ND, the SFRB is under-utilised until the flock is rebuilt. If, for example, it is assumed that the flock is completely wiped out once every 18 months, that it takes 6 months for the flock to be rebuilt, and the SFRB is on average 50% utilised during rebuilding, then there is a spare capacity of 17% in the SFRB. There is no information which can be used to make such an assessment. However, for illustrative purposes, until such data become available, the base assumption in the model is that the SFRB available is the number of adult bird equivalents before ND control plus 17% unused capacity.

The seasonal change in the SFRB has not been included, as it makes the model too complicated for the purpose intended, and at present there are no data to support its inclusion.

***Capital Expenditure***

As the model is based on the preservation of the competitive advantages of the traditional village poultry system, any innovations such as improved housing are based on designs that utilise natural materials readily available from village resources, with little or no cash costs required.

The model is illustrated in Table 2; there are two levels of intervention:

- ND control alone which simply results in lower mortalities in each category of birds.
- Improved model, comprising ND control coupled with a range of other innovations as discussed earlier, which result in further reductions in mortalities, as well as increased output of eggs per hen.

**Table 2. Flock Model and calculations using Mozambican prices.**[1]

| | | Traditional | ND Control Only | | Improved: | |
|---|---|---|---|---|---|---|
| | | | Egg Model | Meat Model | Egg Model | Meat Model |
| **Flock Parameters** | | | | | | |
| No of Hens | | 10.0 | 10.0 | 9.0 | 10.0 | 3.26 |
| % Hens laying | | 60.0 | 60.0 | 60.0 | 90.0 | 90.00 |
| No. of Hens Laying | | 6.0 | 6.0 | 5.4 | 9.0 | 2.9 |
| Clutches/yr | | 3.0 | 3.0 | 3.0 | 4.0 | 4.0 |
| Eggs/clutch | | 12.0 | 12.0 | 12.0 | 15.0 | 15.0 |
| Total Eggs/yr | | 216 | 216 | 194 | 540 | 176 |
| Eggs harvested % | | 0% | 12.0 | 0.0 | 72.3 | 0.0 |
| No. eggs harvested | | 0 | 26 | 0 | 390 | 0 |
| Eggs brooded % | | 100.0 | 88.0 | 100.0 | 27.7 | 100.0 |
| No of Eggs brooded | | 216 | 190 | 194 | 150 | 176 |
| Hatchability % | | 80.0 | 80.0 | 80.0 | 80.0 | 80.0 |
| Day old chicks | | 173 | 152 | 156 | 120 | 141 |
| Chick mortality to 8 wks % | | 62.0 | 45.0 | 45.0 | 31.0 | 31.0 |
| Mortality 8wks to maturity % | | 45.0 | 30.0 | 30.0 | 22.0 | 22.0 |
| Pullets | | 18.1 | 29.3 | 29.9 | 32.2 | 37.9 |
| Cockerels | | 18.1 | 29.3 | 29.9 | 32.2 | 37.9 |
| Mortality - hens & cocks % | | 20.0 | 15.0 | 15.0 | 10.0 | 10.0 |
| Hen:Cock ratio | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| No of Cocks | | 2 | 2 | 2 | 2 | 1 |
| Replacements - hens | | 8.0 | 8.5 | 7.7 | 9.0 | 2.9 |
| - cocks | | 1.6 | 1.7 | 1.7 | 1.8 | 0.9 |
| **Adult Bird Equiv.(ABE)** | | | | | | |
| Cocks | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Hens | | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Pullets&cockerels >8wks | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Chicks to 8wks | | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| **Average Numbers Fed** | | | | | | |
| Cocks | | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 |
| Hens | | 10.0 | 10.0 | 9.0 | 10.0 | 3.3 |
| Pullets&cockerels >8wks | | 50.9 | 71.1 | 72.7 | 73.5 | 86.5 |
| Chicks to 8wks | | 119.2 | 117.8 | 120.5 | 101.1 | 119.0 |
| Total ABE | | 38.7 | 46.7 | 46.7 | 46.5 | 46.5 |
| Un-utilised Feed Resource % | | 17.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total ABE Available** | | 46.6 | 46.7 | 46.7 | 46.5 | 46.5 |
| **Mozambique Income/Consumption** | **Unit Value (USD)** | **No. Sold** | **No. Sold** | **No. Sold** | **No. Sold** | **No. Sold** |
| Eggs | 0.04 | 0 | 26 | 0 | 390 | 0 |
| Pullets | 1.40 | 10 | 21 | 22 | 23 | 35 |
| Cockerels | 1.40 | 16 | 28 | 28 | 30 | 37 |
| Hens | 1.80 | 8 | 9 | 8 | 9 | 3 |
| Cocks | 2.00 | 1.6 | 1.7 | 1.7 | 1.8 | 0.9 |
| **Gross Income (USD)** | | 55.00 | 87.00 | 88.00 | 110.00 | 108.00 |
| **ND Vaccination Costs (USD)** | 0.02 | 0 | 10.00 | 10.00 | 10.00 | 11.00 |
| **Net Income (USD)** | | 55.00 | 78.00 | 78.00 | 100.00 | 97.00 |

[1]Mozambican prices were used but are expressed here in USD

Each of the intervention levels has two sub-models: an egg model and a meat model. In the egg model, egg harvesting is the mechanism to adjust the feeding pressure on the SFRB until it equals the total ABE in the pre-ND control situation. In the meat model, no eggs are harvested, but the number of hens is reduced until the total ABE is equal to the pre-ND control situation. The results indicate that there is little difference in terms of household welfare between either of these sub-model options. In practice farmers may opt for a combination of the two. In the model, the relevant cell in a spreadsheet (% eggs harvested, or the number of hens) is changed until the ABE figure equals the pre-ND control total ABE. The flock structure and turnoff is automatically changed.

The results indicate that, for the set of assumptions used, household income increases by 42% for ND control only. This compares with a similar estimate by ACIAR [15] that productivity increases by 40% when such technology is adopted.

Furthermore, when ND control is coupled with other initiatives, the model shows an increase in household income of 82% above pre-ND control levels.

The above results, of course, are not based on specific data, and are illustrative only of the results that may be achieved. While the traditional model is based on the literature, and portrays a typical African village chicken flock, the parameters for the post-ND interventions are purely assumption based. It will be some years before there are sufficient data to indicate whether such assumptions are realistic.

## BASELINE AND PRA STUDIES OF HOUSEHOLD WELFARE

The Southern Africa Newcastle Disease Control Project has conducted baseline and participatory rural appraisal (PRA) studies in Cahora Bassa District, Tete Province, Mozambique, on an annual basis. The principal intervention in the project area has been the implementation of ND vaccination campaigns by community vaccinators using locally produced I-2 ND vaccine administered via eye drop at four-monthly intervals.

In late January 2003, 150 farmers were interviewed and 101 farmers were interviewed in February 2004. The composition of the households interviewed in the survey was based on the following criteria:

1. Gender
2. Chicken ownership
3. Vaccination practices
4. Social category

The questionnaire was designed to identify changes in:

- Knowledge,
- Attitude,
- Practices, and
- Wellbeing.

The main purpose of the baseline and review exercise is to measure the extent of the changes generated by the project and to measure the cost-effectiveness and sustainability of the approach. The aim was to interview 50% male and 50% female farmers using systematic random sampling. In practice this approach was modified and 20 households were selected at random from each project village.

Preliminary results from the 2004 survey are available allowing some comparisions to be made with the 2003 data. After the first year of the project average village chicken flocks of participating farmers increased from 5 to 13 birds and home consumption and sale of both birds and eggs also increased (Table 3).

**Table 3:** Comparison of baseline data collected in Cahora Bassa District, Mozambique in January 2003 and February 2004.

| Category | 2003 | 2004 |
|---|---|---|
| Average number of chickens per household | 5 | 13 |
| Number of chickens eaten during the previous one month | 2 | 3 |
| Number of eggs eaten during the previous one month | 8 | 10 |
| Number of chickens sold during the previous one month | 3 | 3 |
| Number of eggs sold during the previous one month | 0 | 10 |
| Number of chickens lost to disease in the past six months | 11 | 5 |
| Percentage of farmers vaccinating their chickens against ND | 15.7% | 69.4% |

PRA studies were conducted in two villages in 2003 and 2004 in parallel with the completion of the baseline questionnaires. The following are the major areas where changes have been identified:

- Size of flock,
- Numbers of chickens and eggs sold and bartered,
- Numbers of chickens and eggs consumed by the family,
- Other types of use of chicken products,
- Numbers of chickens vaccinated,
- Knowledge and attitude towards vaccination,
- Nutritional knowledge and knowledge of practices in regard to chicken products,
- Knowledge, attitude and practices regarding poultry management,
- Knowledge, attitude and practices regarding participation,
- Changes in well-being caused by changes in the volume of chicken products available,
- Changes in gender relations as a result of the changes in knowledge, attitude, practices and well-being generated by the project, and
- Differential changes in knowledge, attitude, practices and well-being between the poorest households and other households.

During the PRA in February 2004 (after the vaccination campaigns in 2003), both men and women when interviewed in groups of the same sex said that they observed a decrease in chicken mortality following vaccination. In the group of twenty men interviewed, all had vaccinated their chickens. They said that as the result of the vaccination, the number of chickens owned by each household had increased. In the group of seventeen women, only a few vaccinated their chickens. But they said that they were able to see the difference in mortality between vaccinated and non-vaccinated chickens. With the increase in the number of chickens, men and women mentioned an increase in sales more often than an increase in consumption.

## DISCUSSION AND CONCLUSIONS

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

This situation presents a very attractive opportunity to enhance the benefits of ND control, by developing suitable extension programmes to promote village chicken development in a post-ND environment. The advantages that village chickens offer are increasingly being recognised:

- They are widespread throughout the rural areas, especially for the poorest households,
- Significant and widespread benefits can be achieved without the need for any expenditure in infrastructure and farm development; complex new technology; funding for the purchase of

inputs; credit; or basic training of farmers (they have been dealing with village chickens for hundreds of years), and

- Smallholders can produce chickens at little or no cost, which therefore has a very significant competitive advantage over almost any other income producing activity that they may choose, and is practically risk free, with or without ND control.

To facilitate the development of appropriate extension packages, clear national policies for the development of the poultry sector are required for both village chicken and intensive poultry production. It is suggested that interventions in village chickens should be designed so as not to alter the natural competitive advantages that village chicken production has in rural areas. There will continue to be significant risks of disease, predation and theft following ND control, and any interventions in remote rural areas (where access to large markets and commercial inputs is lacking) which involve purchased inputs or other cash outlays should be avoided, as poverty and food security are likely to deteriorate under such conditions..

It is obvious in districts where ND vaccination has been introduced that there is a rapid impact, and farmers quickly start to look for the next steps in improving their chicken production. The new challenge is for the extension service to assist farmers in their quest for advice and solutions for some of the other constraints that take on greater significance once ND disappears. The emergence of other diseases, particularly fowl pox, chick mortality, predators, and the finite nature of the SFRB appear to be the most significant problems that need to be considered. It is apparent that many farmers and extension workers do not realise the significance of the SFRB as a constraint to production in a post ND environment; management strategies need to be focused on maximising the turnoff from a given SFRB, which requires careful management of flock size, structure and turnoff.

The literature suggests that there is a high proportion of non-laying hens in village flocks. Pedersen [16] found that only 40-50% of hens in Zimbabwean flocks were productive at any time. Kitalyi [12] reports, in another study, that less than 20% of total mature hens were laying. Discouraging brooding and culling these unproductive hens would have an immediate impact on the average productivity of hens in the flock. Similarly, poor layers should be culled, and only above average hens kept in the flock. Control of brooding also has the potential to significantly increase hen productivity through increases in egg production and the number of clutches per year.

The value of the model is that it illustrates the value to be gained from a holistic approach to ND control; that the potential impact of ND control can be doubled if some additional measures are adopted by farmers, and that these measures need not involve any additional expenditure by government or donors or households (except for some additional family labour and the preparation of appropriate extension messages).

More detailed benefit-cost analyses will be conducted following the third baseline and PRA studies in 2005. However, an analysis of the baseline and PRA studies conducted in 2003 and 2004 revealed an improvement in village chicken production in participating households and, consequently, increased income generation and food security.

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