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Village poultry production system: Perception of farmers and simulation of impacts of interventions

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This study identified perception of poultry farmers' on impact of interventions in village poultry production and quantified the impacts of interventions on flock and economic performance using modelling. A structured questionnaire was used to collect data on perceptions of poultry keeping and performances from 240 randomly selected households in two districts of Ethiopia. Crop was the major source of income, and poultry generated supplementary income. Farmers perceived that demand and price of poultry products increased. Majority of the farmers believed that additional inputs would not lead to higher income. A dynamic simulation showed that the base situation made a positive financial contribution. Vaccinations had the largest positive impact on flock performances and using improved indigenous chicken had the smallest. Application of interventions had the largest effect on flock performances in the base situation but did not lead to profitability. The sensitivity analysis showed that feed cost had the largest impact on the profitability followed by housing, vaccination and breed. Farmers' perceptions affected their decisions regarding implementation of interventions. Simulated interventions increased productivity but only in a few cases the increased incomes outweighed the additional costs. Interventions need to be tailored towards the local situation to ensure improved productivity and improved income.

Key words: Poultry, smallholders, flock performance, profitability.

INTRODUCTION

It is widely acknowledged that village poultry in developing countries plays an important role as source of animal protein and income for smallholder farmers (Creevey, 1991; Alders and Pym, 2009). In village poultry production systems,farmers raise small number of domestic fowl mainly for home consumption with small mostly seasonal surpluses being sold in villages (Farrelly, 1996). Investments in village poultry farming can improve

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productivity and generate additional income which contributes to poverty reduction and increased food security (Mack and Otte, 2005; Pica-Ciamarra and Otte, 2010). Village poultry are often associated with good quality/size eggs and meat flavor, hard egg shells, high dressing percentages and low production costs (Gueye, 1998). Despite the contribution of village poultry to the national economies of developing countries, the main function of village chickens according to the farmers is the provision of meat and eggs for home consumption (Andrews, 1990; Cairns and Lea, 1990).

Over the last decade, the consumption of poultry products in developing countries grew by 5.8% per annum, faster than that of human population growth (Sonaiya and Swan, 2004). Commercialization of indigenous poultry production might be timely in terms of meeting the needs of the increasing population (Ondwasy et al., 2006). The profitability however, depends very much on feed costs, market prices, stock sizes, and number of birds sold and consumed (Masuku, 2013).

Commercialization of village poultry increase the dependency on modern technologies and inputs (Farrelly, 1996). Before making an investment to increase poultry production, farmers need to be convinced that the investment is economically feasible.Reddy (1998) stated that village poultry production can be more sustainable when farmers use indigenous chicken with appropriate and affordable technologies with 'low external inputs'.

A breeding program aiming at improving the productivity (egg production, survival and body weight) of an indigenous chicken population is underway in Ethiopia (Dana, 2011). The breeding program is run on a research station but the productivity of the improved chickens (Horro) is being tested in the field. To ensure successful adoption of an improved breed, farmers' perceptions towards interventions, the extent to which the improved breed requires additional inputs (feed, housing, vaccination), and the impact on profitability need to be known. Modelling is increasingly accepted tool to increase understanding of the complex interactions of the various parts of farming systems, and to guide resource use decisions about specific technical innovations and to assess the risks and returns from such innovations (Pandey and Hardaker, 1995).

A dynamic model, Village Poultry Simulation Model (VIPOSIM) was developed at Wageningen University, the Netherlands, and was validated on data from Ethiopia (Asgedom, 2007). VIPOSIM considers the dynamics of village poultry production systems by incorporating flock off-take, egg production, egg loss, egg off-take and reproduction. The model determines the flock dynamics and performances and performs a cost-benefit analysis. It performs calculations in time steps of 3 months which represents the reproduction cycle: The period a hen needs to produce and hatch eggs and rear chicks up to an age of 8 weeks. The maximum number of steps in the model is 12, which corresponds to a period of three years (Asgedom, 2007). It was programmed in Microsoft Excel®. The input variables include chicken production and management parameters such as initial size and composition of the flock, mortality rates for different categories, bird sales and consumption rates, egg production, reproduction parameters (incubation and hatching), egg sales, egg loss, egg consumption rates, and bird off-take limits. The economic parameters such as prices of birds and eggs and costs are also input variables. Costs are categorized into overall costs per bird per season for each intervention. As output, the model gives the values of bird off-take and egg off-take, and the final composition of the flock for each season during the three-year period of simulation.

The model can be used to perform a sensitivity analysis by varying a financial value of an individual intervention while the others are kept at their base situation (default), so showing the consequences of the change (s) of varying the value of an uncertain parameter. The outcome variable can be any performance measure or indicator. Results of a sensitivity analysis were presented in a tornado diagram (Eschenbach, 1992). This ranks a large number of variables in their order of importance without becoming over crowded. It shows the lower and upper values of the outcome variable (profit in our case) obtained from the variation of each variable (inputs), with the variable with the widest limits displayed on the top, and the parameter with smallest on the bottom, indicating the widest the limits the more attention the parameter deserves. It is important to note that the width obviously depends on the actual difference between the high and value input value which is the total cost of the base situation in this study.The objectives of this study were (1) to determine the perceptions of rural farmers towards feasibility of interventions in their village poultry system, (2) characterize the existing village poultry production system (base situation) (3) evaluate the impacts of individual and packaged interventions into the existing production system.

MATERIALS AND METHODS

Research design

The study employed a structured questionnaire survey andthedynamic simulation model VIPOSIM (Asgedom, 2007). The survey was conducted in the Horro and Ada districts of Ethiopia in 2011. These districts were used for an on-farm evaluation of the improved indigenous chicken. They represent village poultry production system areas, but they differed in distance to the major market. Participatory rural appraisal was used to formulate the structured questionnaire for the survey which aimed to capture farmers understanding of the village poultry production systemand togatherbaseline input for our modelling. A two stage sampling procedure was followed to select eight villages and 30 sample households from each villagein both districts. In the first stage, four rural villages from each districtwere selected purposively based on their prior experience in applying innovations. In the second stage, individual households were selected using systematic random

Table 1. Interventions used in previous studies.

Interventions	Description	Impact	References
Feed	Supplementary feed	50% more eggs, 15% earlier age at first egg	Tadelle (1996); Siamba et al. (1999)
Housing	Night shelter and fencing	Mortality from predation lowered to 0 %	Okitoi et al. (2006) and Prasetyo et al. (1985)
Vaccination	Mainly Newcastle disease	50-80% lower mortality	Sonaiya (1990) and Gueye (1998)
Breed	Improved indigenous chicken	More than 45.8% increase in egg, mortality lowered to 3%	Dana (2011)

Table 2. Opinions of household heads towards village poultry production system.

Characteristics [Number of respondents (n=240)]	%
Which is more profitable income generating activity	
Crops	89
Livestock	11
Keeping poultry support family income	
Yes	54
No	46
Did you notice improvement in livelihood (past three years)	
Yes	83
No	17
How do you see the demand (past three years)	
Increasing	60
Decreasing	40
How do you see the current price of chicken and egg	
Increasing	68
No change	21
Decreasing	11
Why did not you use more inputs	
Not profitable	85
Profitable	8
Break-even	7
Does indigenous chicken produce less than exotic	
Yes	77
No	27

sampling. Systematic random sampling is often used to select large samples from a long list of households by using a sampling interval (Bellhouse, 2005). A total of 240 household heads (120 from each district) were randomly selected and interviewed by 12 enumerators. Each interview took on average one and half hours. The results of both districts were analyzed and differences in responses were examined using a t-test (SPSS, 2008).

Formulation of interventions

Based on the result of the survey and previous studies (Table 1) the following interventions were hypothesized to affect the productivity of the flock positively. (1) Formulated feed that contains standard level of protein and energy. (2) Improved indigenous breed (Horro). (3) Improved housing (4) Full vaccination against major diseases along with disinfectants and vitamins. Improved indigenous chicken demands the use of supplementary feed. The improved breed intervention was chosen to represent performance of chickens that resulted from the selective breeding program on Horro chicken at DebreZeit station (Dana et al., 2010a). The use of vaccination demands confining the chickens in a house (to avoid the potential re-infection) and provision of feed. Feed was used alone as it can be given at a fixed time of the day and chickens can be left to roam around.

RESULTS AND DISCUSSION

Perceptions of farmers

Perceptions of farmers towards poultry production are presented in Table 2. The majority of respondents

Table 3. Average flock characteristics found in the survey of farms in two districts, p-value of the difference between the districts and the average value used to model the base situation.

Parameter	Ada	Horro	P-value	Average
Flock size (No.)	26	27.7	0.25	27
Mortality (%) (predation, diseases, others)	59	55.5	0.40	57
Bird off-take (%) (consumption and sale)	29.3	28.7	0.84	29
Egg production (eggs/clutch)	15.2	15	0.93	15
Egg off-take and losses (%) consumption, sales)	51.5	50	0.57	50
Egg set for hatching (%)	52	48.3	0.09	50
Hatchability (%)	78	80	0.65	79

perceived crops as the most important income-generating activity, but over half of them keep poultry to support family income. The focus of governments in developing counties is also more oriented to crop production. Mack and Fernandez-Beca (1990) stated that improving livestock production in rural areas is restricted to providing improved forages and vaccinations rather than promoting interventions aimed at improving overall livestock's contribution to livelihoods. The majority of respondents perceived an increasing demand of poultry products and responded that the prices for poultry products had increased in the last three years. The majorityof respondentsalso perceived that their poultry are low producing, and believed that using extra inputs in their poultry production is not profitable. The result of this study showed that the perception of rural farmers were in line with the feasibility of simulated interventions into the existing poultry production system. Farmers indicated that their livelihood was improved in the past three years. This might be associated with an increase in the prices of agricultural products in recent years in Ethiopia (Haji and Gelaw, 2012). Farmers perceived an increase in the demand for poultry products and in prices of poultry products in the last 3 years in line with earlier report (Islam, 2003). The prices of poultry products also increased which might be partly attributed to the low supply relative to the demand (Ghafoor et al., 2010). Not only the price of poultry products increased but also the price of inputs increased, leading to unsteady net returns for poultry farmers (Achoja, 2013). This could explain why farmers said they were reluctant to use interventions: spending on inputs might not pay back. Okitoi et al. (2006) stated that improvements in such systems should require limited additional resources leading to only small additional costs.

Characterization of the base situation

Characterization of the existing village poultry production system provides the basis for designing and evaluating interventions. The production characteristics of poultry farms in the two studied regions are presented in Table 3. No significant differences were found between the two districts. Farmers on averagekeep mixed flocks of 15 chicks, 4 pullets, 3 cockerels, 4 hens and 1 cock. Farmers lose 57% of their flock through mortality in one year. The most important reasons reported for mortality were predation, diseases and unknown reasons in line with literature, where mortalities ranging from 50 to 80% were reported (Gueye, 1998; Gueye, 2000). A smaller proportion of birds were either consumed or sold in the village. The observed bird off-take was close to a previous study in northern Ethiopia (Udo et al., 2006). On average 15 eggs per clutch (approximately 3 months) were produced, of which half was used for hatching and lies within the range of annual egg production per hen in village poultry systems (20 to 100 eggs) reported earlier (Sonaiya, 1999). About 50% of the eggs produced were used for hatching and the rest were sold or consumed. The hatchability (79%) was close earlier findings of Kitalyi (1998). This low productivity reflects not only the low genetic potential of the chickens but also the poor feeding and management conditions. The averages of production parameter in the two districts were used in modelling the base situation. Figure 1 presents changes in flock size and flock composition in the base situation.

Evaluation of interventions and cost benefit analysis

Percent flock size, bird off-take, egg production and egg off-take changes as a result of simulated interventions compared to the base situation at the end of the simulated period of three years is presented in Table 4. All interventions, individually and combined had positive impact on the flock performance on flock size, bird off-take, egg production and egg-off-take. The highest effect resulted from combined use of all interventions, followed by vaccination, housing and feed. Breed resulted in the least impact.

Total costs, benefits and net returns for the interventions over the simulated period of 12 seasons are shown in Figure 2. All individual and combined interventions applied to the base situation did not lead to a higher net return. The costs associated with the

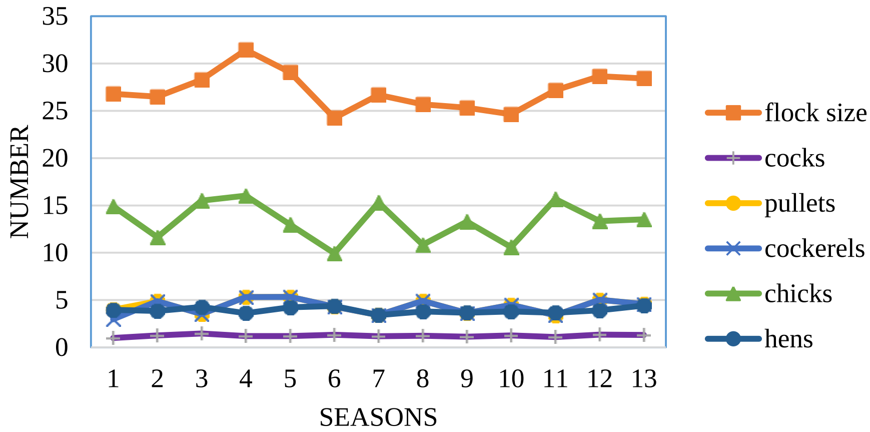

Figure 1. Changes of flock size and flock composition of cocks, pullets, cockerels, chicks and hens over 12 seasons for the base situation.

Table 4. Changes in bird off-take, egg production, egg off-take and flock size as a result of simulated interventions to the base situation at the end of the simulated period of 3 years.

Intervention	Flock size (%)	Bird off-take (%)	Egg production (%)	Egg off-take (%)
Feed	223	268	217	220
Housing	244	292	259	353
Vaccination	324	333	362	364
Breed	154	165	210	111
All interventions	389	317	514	434

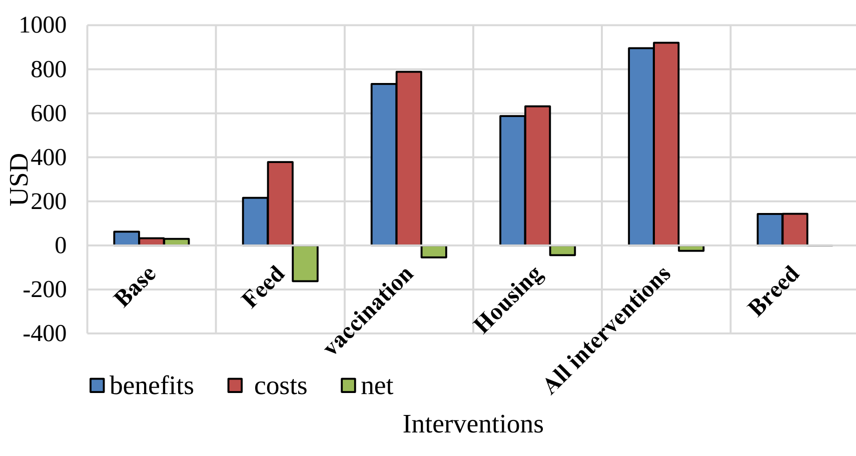

Figure 2. Total costs, benefits and net returns for base situation, feed, vaccinations, all interventions vaccination and breed.

interventions were higher than the additional benefits. The base situation was economically feasible and the use of improved indigenous breed resulted in a break-even.

The explanation could be that whatever small village chickens produce, it is produced with a very little spending from the farmers (Smith, 1990). The results of sensitivity analyses are shown in Figure 3. Changes in the price of feed and vaccinations resulted in negative net profit. The increase in price also resulted in negative returns in the other interventions. However, feed cost is the most sensitive as it showed thewidest range of negative impact on profitability. This might mean that with the current price of feed, it is not possible to make any profit. Masuku (2013) recommended that farmers should

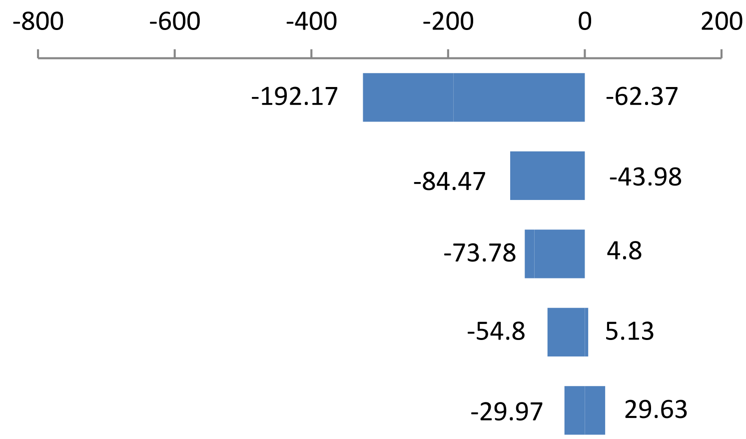

Figure 3. A tornado diagram showing the range of variables representing the net profit ($) for high and low values of feed, housing, vaccinations breed and all interventions ranked from top to down in order of magnitude of influence.

organize themselves to take advantage of discounts when purchasing feed. The simulation result showed that all interventions applied to the base situation increased flock performances. Package application resulted in the maximum flock performance followed by vaccination and housing. Vaccination is one of the most important technical possibilities to improve village chicken production (Tomo, 2009). Vaccination against Newcastle alone can save 50 to 100% of mortality caused by this disease among chickens in rural areas (Alders and Pym, 2009; Jordan and Alderson, 2009). Housed chickens produce more as predation and harsh weather can be avoided (Prasetyo et al., 1985). In the scavenging system, supplementation is rarely practiced. Application of interventions resulted in a positive flock performance but negative profit. The poor profitability seen in this study might be associated with a flock size of non-economic scale. As hypothesized, the perception of farmers influenced their decision towards the village poultry production system. Farmers' perceptions were logical, and derived from their experiences that the productivity from this system is low but still important. At regional level, poultry production is important seeing the increasing demands. The village poultry production system in different areas seems to be very similar even though they are located farm from each other. Increased productivity was realized when more inputs were applied. However, the study clearly demonstrates that higher productivity does not necessarily lead to higher income. The simulation of the use of improved breed resulted in only a break-even.

Conclusion

In conclusion we found that Farmers' perceptions affected their decisions regarding implementation of interventions. Simulated interventions increased productivity but only in a few cases the increased incomes outweighed the additional costs. Interventions need to be tailored towards the local situation to ensure they lead not only to improved productivity but also to improved income.

Conflict of interests

The authors have not declared any conflict of interest.

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