Comparison of economic impact of alternative constraint control measures in indigenous chicken production in Nyanza Province, Kenya

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Abstract

This study compared the costs and benefits of six alternative control measures on the indigenous chicken productivity constraints with an aim of identifying the most desirable mitigation measure; for improved productivity of the birds. The study was conducted in Migwa and Kagak villages in Kasipul division of Rachuonyo South district. The study first used rapid rural appraisal (RRA) tools as described by Chamber (1994); to prioritize the constraints limiting indigenous chicken production in the study area. A twelve month set of controlled intervention trials in 80 study households, were designed into six intervention and one control groups, was later carried out to test for effects of the mitigation measures on the prioritized constraints that were: diseases (Newcastle, Gumboro and fowl pox), predations (in chicks) and inadequate nutrition, in order of importance, respectively. Productivity parameters and rates that included clutch sizes and numbers, flock sizes and structures, mortality, hatchability and chick survival rates were monitored during the entire study period. The data was obtained by actual measurement, on spot observation, interview of household members directly responsible for the care of the indigenous chickens, community group discussions, post mortem examination on sick and fresh dead birds and laboratory sample analysis (from sick and dead birds). Benefits and costs analysis technique was then applied to identify the most desirable mitigation measures by comparing the net present values (NPVs) of the six alternative intervention approaches.

The study identified integrated intervention, which included concurrent control, by vaccinations, of important indigenous chicken diseases (Newcastle, Gumboro and fowl pox), prevention of predations (especially in chicks by confinement) and improvement of the birds' nutrition by consistently providing maize grains and chicken left over supplementations; as the most appropriate and sustainable technology, for the improvement of productivity of the indigenous chickens.

Key words: indigenous chicken vaccinations, chick confinement, grain supplementations

Introduction

Kenya is mainly an agricultural country. The agriculture sector accounts for about 60% of the foreign exchange earnings and employs over 70% of the total labour force in the country. The sector contributes 25-26% of gross domestic product (GDP) of which 4% is from the poultry sub-sector (Kenya National Bureau Statistics (KNBS) 2010). There has been, notably, a decline in the agricultural sector's contribution to GDP growth over the past few years, but it still remains one of the most important sectors driving economic growth and plays central role in employment generation (Ministry of Agriculture (MA) 2010; KNBS 2010). There is need to improve agricultural productivity in order to achieve self-sufficiency in food production, and reduce poverty through increased income, especially in rural areas.

Poultry has been identified as one of the lead livestock enterprises that can boost agricultural production; it is one of the fastest growing and promising industries in Kenya (Nyaga 2007). Improving the productivity of the indigenous chickens; that comprise over 70% of the 30 million domesticated birds and are mainly kept by the resource-poor rural families in Kenya, estimated at 75% (Ministry of Livestock Development (MLD) 2010), is one way of achieving this.

The chicken production requires low initial investment capital to start and it is always an affordable source of livelihood in terms of food and cash income for resource-poor people, especially women and children (Olwande 2009; Wachira et al 2010). The birds contribute 60% of the total egg and poultry meat produced in Kenya (Nyaga 2007) and therefore impact significantly on the rural trade, welfare and food security of small holder farmers. The average household is reported to keep between 10-20 birds per flock (MLD 2010; Olwande et al 2010), indication of low productivity.

There are two distinct poultry production systems in Kenya, namely intensive and extensive. Intensive system is usually found in the urban and peri-urban areas and uses the improved (hybrid) breeds. Indigenous chickens are mainly raised in rural areas under extensive (scavenging) free system, the production is small-scaled and most households use family labour and, where possible, locally available feed resources (Okitoi et al 2007; Okeno et al 2012). Chickens under extensive system range freely during the day and find much of their own food; however, some little and inconsistent grains/ kitchen left over supplements are given. Housing is done at night, mainly in human dwellings to protect the birds from wild animals and thieves (Olwande et al 2010; Wachira et al 2010; Okeno et al 2012). The extensive system exposes the indigenous chickens to harsh conditions such as diseases, predation, inadequate feeding, poor housing and extreme weather changes, resulting in low productivity (Ondwasy et al 2006; Wachira et al (2010); Okeno et al 2012).

Research efforts have come up with several recommendations, aimed at improving the productivity of indigenous chickens; surveys however, still report low productivity, even after most of the recommendations are implemented by the farmers (Olwande et al 2010; Wachira et al 2010). The meaning of this could be that, appropriate mitigation measures to manage the constraints and improve productivity of the chickens are not yet identified by the previous efforts (Nyaga 2007; Wachira et al 2010).

This study first identified and prioritized indigenous chicken productivity constraints using rapid rural appraisal (RRA) methods. This was followed by controlled intervention trials on three most important constraints for 12 months in order to come up with probable interventions that are sustainable within the indigenous chicken category.

Benefit-cost analysis technique as described by Garrison (1991) was used to compare the NPVs of the alternative interventions. The technique has two approaches; the net present value (NPV) method, and the time-adjusted rate of return; sometimes called the internal rate of return (IRR) method. The NPV method was used because it has a number of advantages over the IRR method. First, the NPV method is simpler to use; the IRR method often requires a trial-and-error process to find the exact rate of return that will equate a project's cash inflows and outflows. No such trial-and-error process is necessary when working with the NPV method. Second, using the NPV method makes it easier to adjust for risk than using IRR method. And lastly, the NPV method provides more usable information than does the IRR method.

Materials and methods

Study areas

The study was conducted in Migwa and Kagak villages of Rachuonyo district in Nyanza Province, Kenya.

Methodology

The study first used rapid rural appraisal (RRA) tools that included community group discussions, key informants interviews, matrix scoring, simple and proportional ranking to assess the constraints limiting indigenous chicken production. This was followed by controlled intervention trials in 80 households sampled by cluster method; 40 in each of the two study villages (Migwa and Kagak). The 80 households were then designed into six intervention and one control groups. Apart from the control group, each of the six intervention groups participated for 12 months in one of the intervention trials that included confinement of chicks, vaccination against one of the three prioritised indigenous chicken diseases; Newcastle, Gumboro and fowl pox, consistent supplementation of birds with maize grains and kitchen left over and an integration of all the above five trials (vaccinations against Newcastle, Gumboro and fowl pox diseases, chick confinements and consistent feed supplementations), more details are provided in the subsequent sections.

The productivity parameters and rates, which included clutch sizes and numbers, flock sizes and structures, and mortality, hatchability and chick survival rates were monitored during the entire study period. The data was obtained by actual measurement, on spot observation, interview of household members directly responsible for the care of the indigenous chickens, community group discussions, post mortem examination on sick and fresh dead birds and laboratory sample analysis (from sick and dead birds).

Benefits and costs analysis technique was then applied to identify the most desirable mitigation measure.

Interventions against Newcastle, Gumboro and fowl pox diseases

Routine vaccinations against Newcastle, Gumboro and fowl pox diseases were carried out for one year in indigenous chickens in three intervention groups consisting of 11, 10 and 10 households, respectively. Vaccinations were randomly assigned to the three intervention groups. The groups were named according to the type of vaccination programme assigned to it, thus, *Newcastle vaccinations only* (NVO), *Gumboro vaccinations only* (GVO)*; and fowl pox vaccinations only* (FPVO), for the Newcastle, Gumboro and fowl pox vaccinations, respectively. The groups were then monitored for key indigenous chicken productivity parameters like clutch and flock sizes and chick survival, and mortality rates for the intervention period.

Intervention against chick predation

This intervention trial was carried out in one group consisting nine households. It involved confinements of chicks and thus, this group was named *chick confinements only* (CCO) group. Day old chicks were housed/ confined during day time in *Osera* (special basket for protecting/ confining chickens) for up to three months of age to keep them from predators. The chicks were provided with a mixture of commercial chick feeds and locally available feeds; grains and kitchen left over, and water given *ad libitum*. At the age of three months the birds were expected to be able to escape from the birds of prey and other predators.

Consistent maize grains and kitchen left over supplementations intervention

This group consisted of 10 households and was respectively named *consistent maize grains and kitchen left over supplementations only* (CGKSO) group. Farmers were supplied with maize grains for one year, to use as supplement for their indigenous chickens, along side kitchen left over. These households were visited quite regularly; at least twice a month to ensure that consistent supplementations were being done. This was meant to counter the previous situation in almost all the households where grains and kitchen left over supplementations to the chickens had been very erratic. The productivity parameters were observed for the one year period.

Integrated (combined) interventions

An integration of all the above mentioned interventions (vaccinations, chick confinement and feeding) was applied to eleven households, respectively named *combined interventions* (COIN) group. The integrated interventions were run for one full year in the intervention group with productivity parameters monitored for the same period.

Control group

The control group consisted 19 households. No interventions were carried out, as productivity parameters were observed for one year.

Procedures for economic analysis

Benefit-cost analysis method was used to find the financial benefits of the intervention approaches. This technique uses a discounting process that takes care of the time value of money and depreciation aspect of assets. The average current commercial banks' lending rate of 24% was used as the discounting rate. Firstly, the total costs incurred during the interventions and benefits gained by the reduction in chicken mortality were estimated. The total costs and benefits were then discounted at 24% rate of return to obtain the present value cost (PVC) and present value benefits (PVB), respectively. The PVC was subtracted from PVB to obtain the net present value (NPV) that if positive, would be an indication that the intervention was beneficial. Intervention measures that would provide the largest positive NPV would be most desirable.

Data management and statistical analysis

All the data obtained from the field were entered in Microsoft access programme (Microsoft Corporation 2000). Descriptive statistics such as mean, range, frequency and percentage were obtained using Statistical Package for Social Scientist (SPSS for windows 10) and Microsoft Excel (Microsoft Corporation 2000).

Results

Constraint ranking

Diseases were ranked as the most important constraints in both villages. Predation was ranked second most important, while scarcity of feed came third in ranking. Other important constraints identified were theft, poor animal health service delivery, inadequate poultry management skills among farmers, poor housing, neglect by Government, poverty amongst farmers and farmers' low attitude. Newcastle was the most important disease in terms of prevalence and mortality. Gumboro disease ranked second, while Fowl pox ranked third most important. Fowl typhoid was ranked as the fourth most important disease. Other diseases were non-specific coughing, helminthosis and ascitis in that order.

Indigenous chicken mean household sizes and structures

Table 1 presents mean indigenous chicken flock sizes per household. Households that applied the integrated intervention approach (combination of all the five interventions) recorded the largest mean flock size. The mean flock size was statistically different from those recorded in the other intervention groups; with p-value of 0.000 (FPVO and control), 0.001 (CCO) and 0.018 (NVO and CGKSO). Mean flock sizes in the NVO and CGKSO groups were similar (p-value = 0.757), and were second largest (Table 1). The two mean flock sizes were statistically smaller than that of the COIN group but larger than those of the FPVO, GVO, chick CCO and control groups (p-value ranging from 0.000 to 0.002). The mean flock sizes for the last three intervention groups were statistically similar (p-value from 0.203 to 0.615).

Table 1. Mean household flock sizes by interventions (interventional study) in Migwa and Kagak villages; September 2010 - August 2011

Interventions	Number of households	Mean flock size	Std. Deviation
COIN	11	43.0[a]	15.3
Control	19	15.8[b]	8.17
FPVO	10	17.5[b]	8.93
GVO	10	19.7[b]	6.55
CCO	9	19.6[b]	8.34
NVO	11	29.2[c]	5.44
CGKSO	10	28.2[c]	9.85

Means with different superscript letters are different at 95% confidence level

Table 2 presents mean indigenous chicken flock structures per household. The intervention group that combined all the five interventions statistically had highest mean household numbers of chicks, growers and hens compared to the other groups (p-value = 0.000). The mean numbers of birds in the three age categories were also statistically higher in the NVO and CGKSO groups than in the control, CCO and GVO and FPVO groups (p-value ranged from 0.005 to 0.028), except for mean number of growers in CGKSO group, where the p-value was 0.054. The mean numbers of cocks were statistically similar across all the intervention groups (p-value > 0.05). The mean numbers of birds within the three age categories were statistically similar in the control, CCO, GVO and FPVO groups (p-value > 0.05). Similarly the mean numbers of birds within the three age categories in NVO and CGKSO groups were statistically similar (p-value > 0.05).

Table 2. Indigenous chicken household flock structures by interventions (interventional study) chickens in Migwa and Kagak villages; July 2010 - August 2011

Interventions	Statistics	Chicks	Growers	Cocks	Hens
COIN	Mean	20.9[a]	14.73[d]	0.82[g]	6.73[h]
	Std. Deviation	6.41	6.99	0.41	2.72
Control	Mean	8.58[b]	4.32[e]	0.68[g]	2.32[j]
	Std. Deviation	4.21	3.70	0.58	1.34
FPVO	Mean	8.50[b]	5.90[e]	0.40[g]	2.70[j]
	Std. Deviation	4.70	4.68	0.52	1.34
GVO	Mean	9.90[b]	6.80[e]	0.50[g]	2.30[j]
	Std. Deviation	3.41	4.26	0.53	.68
CCO	Mean	10.9[b]	4.89[e]	0.56[g]	3.44[j]
	Std. Deviation	4.81	2.76	0.53	1.42
NVO	Mean	15.2[c]	9.36[f]	0.73[g]	3.91[k]
	Std. Deviation	4.36	3.44	0.47	1.14
CGKSO	Mean	14.1[c]	9.20[e]	0.60[g]	4.10[k]
	Std. Deviation	6.52	5.12	0.52	2.28

Means in the same column for each parameter with different superscript letters are different at 95% confidence level

Descriptive statistics of flock structures in terms of chicken days in Migwa and Kagak villages

Table 3 presents total and mean chicken days for the study area. Mean chicken days for the COIN group was statistically larger than those of the other groups (p-value = 0.000 to 0.044). Means for NVO and CGKSO were statistically similar (p> 0.05); but were larger than those for CCO, FPVO, GVO and control groups; with p-values ranging from 0.003 to 0.050.

Table 3. Total and mean chicken days (interventional study) chickens in Migwa and Kagak villages; July 2010 - August 2011

Interventions	Chick chicken days	Grower chicken days	Adult chicken days	Total chicken days	Mean household chicken days
COIN	76407	50008	29202	155617	14147[a]
Control	62770	32597	26398	121765	6409[c]
FPVO	31746	21403	12167	65316	6532[c]

GVO	35760	23352	12778	71890	7189[c]
CCO	34065	15083	13384	62532	6948[c]
NVO	57529	33574	19837	110940	10085[b]
CGKSO	48301	33331	17765	99397	9940[b]

Key = Means with different superscript letters are different at 95% confidence level

Egg production and hatchability

The study reported mean clutch size of 13 eggs per hen and two to three clutch numbers in one year. Hatchability rate was reported as 87.2%.

Chick survival rates

Chick survival rates for the intervention groups are given in Table 4. The COIN group recorded the highest survival rates (80.64%), followed by NVO (43.55%). The other intervention groups; CCO, control, FPVO, GVO and CGKSO recorded lowest survival rates ranging 22.9 – 36.8 %

Table 4. Mean household chick survival rates by interventions (interventional trials) chickens in Migwa and Kagak villages; July 2010 - August 2011

Interventions	Survival rate (%)
COIN	82.6
Control	23.9
FPVO	33.8
GVO	35.0
CCO	22.9
NVO	41.9
CGKSO	36.8

Indigenous chicken deaths

Table 5 presents number and monthly crude mortality true rates of the indigenous chickens in the study villages. The crude monthly mortality rates were lowest in the group that carried out combined interventions (0.0191per chicken months at risk). The rates in COIN group were 12.13, 9.97, 9.0, 7.91, 6.26 and 6.12 times lower than that in control, CCO, GVO, FPVO, CGKSO and NVO groups; respectively. The highest monthly mortality rates were recorded in control group. Indigenous chickens in the control group were 12.13, 1.98, 1.94, 1.5, 1.35 and 1.22 times more likely of dying than those in the COIN, NVO, CGKSO, FPVO, GVO and CCO groups, respectively.

Table 5. Mean, number and monthly true rates of mortality of the indigenous chickens by interventions (interventional trials) chickens in Migwa and Kagak villages; July 2010 - August 2011

Interventions	Mean	Number	Monthly rates
COIN	9.00[a]	99	0.02
Control	49.5[b]	940	0.23
CGKSO	39.6[b]	396	0.12

GVO	41.2^{b}	412	0.17
CCO	44.1^{b}	397	0.19
NVO	39.3^{b}	432	0.12
FPVP	32.9^{c}	329	0.15

Key = Means with different superscript letters are different at 95% confidence level

Impact of interventions

Estimation of the increased numbers of off-takes and potential values of indigenous chickens and costs of production per flock from interventions

Tables 6 and 7 present increase in off-takes and potential values of indigenous chickens and costs of production per flock from interventions. The increase in off-takes per flock was estimated using entry and exit rates and flock structures. The potential values were estimated using live bird farm gate prices. Average farm gate prices for eggs, chicks, growers, and adults (hens and cocks); in Kenya shillings were 10.00, 200.00, 400.00 and 500.00, respectively.

Table 6. Estimated numbers of increased off-takes and potential values in Kenya shillings (in brackets) in chicks, growers and hens categories by interventions (interventional study) in Migwa and Kagak villages; July 2010 - August 2011

Interventions	Chicks	Growers	Adults	Eggs	Total value
COIN	8.24 (1648)	7.76 (3104)	3.47 (1735)	117 (1170)	7657
NVO	2.21 (442)	3.66 (1464)	1.14 (570)	31.2 (312)	2788
CGKSO	1.54 (308)	4.43 (1772)	1.07 (535)	27.3 (220)	2835
FPVO	-0.12 (-24)	1.16 (464)	-0.47 (-235)	-15 (-150)	55
GVO	0.26 (52)	1.70 (680)	-0.30 (-150)	-8(-80)	502
CCO	0.30 (60)	-0.11 (-44)	0.27 (135)	8 (80)	231

Table 7. Increased costs in Kenya shillings in various intervention groups (interventional study) in Migwa and Kagak villages; July 2010 - August 2011

Interventions	Labour	Feeds	Vaccines	Cages	Total costs
COIN	320	750	250	300	1620
NVO	300	-	200	-	500
CGKSO	320	700	-	-	1050
FPVO	300	-	0	-	300
GVO	300	-	180	-	480
CCO	320	500	-	300	1200

Table 8 presents benefit-cost analysis of the impact of interventions. Discounting rate of 24% is applied; it is the prevailing average commercial banks' lending rates. All benefits and costs are in Kenya shillings. Net present value (NPV) is obtained by subtracting present value cost (PVC) from present value benefits (PVB).

Table 8. Benefit - cost analysis of the impact of interventions (interventional study) in Migwa and Kagak villages; July 2010 - August 2011

Interventions	Year	Sum of	Discount factor at	PVC	Sum of benefits	Discount factor at	PVB	NPV = PVB - PVC

		costs	24%			24%		
COIN	1	1620	0.806	1305	7657	0.806	6171	4865
NVO	1	500	0.806	403	2788	0.806	2247	1844
CGKSO	1	1050	0.806	846	2835	0.806	2285	1438
FPVO	1	300	0.806	241	55.0	0.806	44.3	-197
GVO	1	480	0.806	386	502	0.806	404.	17.7
CCO	1	1200	0.806	967	231	0.806	186.	-781

The COIN group recorded highest NPV (Kenya shillings 4865.75), followed by the NVO group (NPV of Kenya shillings 1844.10), the CGKSO group took third position (NPV of Kenya shillings 1438.70. Lowest NPVs were recorded in GVO (NPV = Kenya shillings 17.70), FPVO (NPV = Kenya shillings, negative 197.50) and CCO (NPV = Kenya shillings, negative 781.00) groups.

Discussion

Vaccination and integrated (combined) intervention trials

Diseases in particular, Newcastle, Gumboro and fowl pox, in order of importance were identified as the most important constraints limiting chicken productivity. Three vaccination interventions; Newcastle (NVO group), Gumboro (GVO) and fowl pox (FPVO) were separately tried as mitigation on respective diseases and impact of each technology on chicken productivity was assessed and compared with that of the combined interventions (COIN) technology; using the net present value (NPV) principle. Fowl pox vaccinations (FPVO) technology recorded a negative NPV with high production losses; an indication that the technology was not financially viable. Gumboro vaccinations (GVO) technology recorded smaller positive NPV compared to Newcastle vaccinations (NVO) technology; indicating that of the three vaccination interventions tried, NVO was the most viable one financially. Although GVO and NVO technologies recorded positive NPV; proof of financial viability, each of the technologies recorded high production losses (from deaths and other causes), with no tangible improvement in productivity of the birds. The COIN technology recorded the highest NPV and lowest production losses of all of the technologies used in the whole study. The COIN technology in addition recorded the highest chick survival rates and mean household flock sizes compared to the rest. The COIN technology is therefore the most suitable for the improvement of the indigenous chicken productivity.

Intervention trials on the indigenous chicken predations

Predation in chicks was identified as a major constraint to indigenous chicken production in the study area. Chick confinements only (CCO) technology was tried to prevent chick predation and improve productivity of the indigenous chickens. The benefits of CCO technology were compared with those of COIN technology in terms of financial viability using the NPV. The CCO technology recorded a negative NPV; indicating it was not financially viable. The technology was able to control predation in chicks but was unable to control diseases and hence failed to improve chick survival rates. Massive chicken deaths from diseases (Newcastle, Gumboro and fowl pox) across all ages were reported in some of the households practicing the technology; some owners got discouraged and stopped confining their chicks all together. The COIN technology was very successful in controlling chick predations and major indigenous chicken diseases (Newcastle, Gumboro and fowl pox); and hence recorded high chick survival rates (over 80%) and overall improved productivity of the chickens. The technology recorded the highest net present value (NPV) and proved to be the more viable financially; compared to the CCO technology.

Intervention trials on inadequate feeding

Poor nutrition, which could be attributed to low level of supplementation resulting in low egg production, was found to be the third most important constraint to indigenous chicken productivity. The CGKSO technology was tried as mitigation on poor nutrition status in the indigenous chickens with an aim of improving the productivity of the birds. The benefits of this technology were compared with those of COIN technology in terms of financial viability using the NPV principle. It was found that although the former technology had a positive NPV and proved financial viability; it was unable to address other important indigenous chicken constraints. High production losses; from deaths and other causes were recorded in the households that were applying the technology (CGKSO) alone. The NPV for COIN technology was larger and general production losses were minimal in the households practicing the technology; it reduced mortality and increased mean flock sizes. Combined interventions (COIN) technology was therefore more desirable than CGKSO technology for the improvement of the productivity of indigenous chickens.

Conclusion and recommendations

- Multiple factors are involved in lowering the productivity of the indigenous chickens. It therefore requires integrated mitigation approaches to address the low productivity associated with indigenous chicken production. This study identified integrated intervention, which included concurrent control, by vaccinations, of important indigenous chicken diseases (Newcastle, Gumboro and fowl pox), prevention of predations (especially in chicks by confinements) and improvement of the birds’ nutrition by consistently providing maize grains and chicken left over supplementations; as the most appropriate and sustainable technology, for the improvement of productivity of the indigenous chickens.

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