Determinants of adoption of management interventions in indigenous chicken production in Kenya

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Abstract

In Africa, many rural farming households keep indigenous chickens (*Gallus domesticus*) in traditional scavenging systems characterized by low input and low output. To improve productivity, African governments and development partners disseminate a management intervention package consisting of feed supplementation, vaccination, brooder, chick rearing equipment and improved housing. Some smallholder farmers adopt the full package, while others adopt the feed supplementation and vaccination only, or the feed supplementation and brooder only. This study surveyed 120 households in western Kenya and analyzed the data using a multinomial logit model to examine these adoption patterns. The factors that were found to significantly influence adoption were access to extension services, female gender, education level, membership of farmer groups and off-farm income. We therefore recommend the formulation of pro-poor policy, focusing on improved extension programs, formation of farmer groups, encouragement of off-farm income earning and improvement of smallholder farmers' socio-economic conditions, to enable these farmers to adopt the package.

Keywords: management intervention package; smallholders; indigenous chicken; multinomial logit; adoption; Kenya

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En Afrique, beaucoup d'exploitants agricoles des zones rurales élèvent les poulets locaux (Gallus domesticus) dans des systèmes traditionnels caractérisés par de faibles intrants et par une faible production, où la volaille est livrée à elle-même. Pour améliorer la productivité, les gouvernements africains et les partenaires du développement diffusent une trousse d'intervention en gestion constituée d'un complément alimentaire, d'un vaccin, d'une couveuse, d'une poussinière et d'un poulailler amélioré. Certains petits fermiers adoptent la trousse dans son intégralité, alors que d'autres n'utilisent que le supplément alimentaire et le vaccin, ou le supplément alimentaire et la couveuse. Cette étude a observé 120 foyers de l'ouest du Kenya et analysé les données en utilisant un modèle logit multinomial pour examiner ces caractéristiques d'adoption. Les résultats indiquent que les facteurs qui influencent l'adoption de manière significative sont l'accès aux services de vulgarisation, le fait d'être une femme, le niveau d'éducation, l'adhésion à des groupements de fermiers et les revenus hors exploitation. Par conséquent, nous recommandons l'élaboration d'une politique en faveur des pauvres ciblant des programmes de vulgarisation améliorés, la formation de groupements de fermiers, l'incitation à générer des revenus hors exploitation, et l'amélioration des conditions socioéconomiques des petits fermiers pour leur permettre d'adopter cette trousse.

Mots-clés : *trousse d'intervention en gestion; petits exploitants ; poulets locaux ; logit multinomial; adoption ; Kenya*

1. Introduction

Indigenous chickens (*Gallus domesticus*), which constitute 80% of the poultry population in Africa, are farmed in traditional scavenging systems (Guèye, 1998). Management interventions are limited or non-existent under most of these systems (Tadelle et al., 2000). Demand for animal food products in developing countries like Kenya is rising and the trends in consumption and production strongly suggest that much of the demand for meat will have to be met through increased poultry production (Delgado et al., 2001). The poultry sub-sector contributes about 1.7% of Kenya's agricultural GDP, which is 25% of the total national GDP (GoK, 2008). Chickens are therefore an important component of rural households' livelihoods, as a source of food, nutrition, income and insurance against emergencies, and they offer potential for commercialization and poverty reduction (GoK, 2005).

The indigenous chicken is Kenya's most important type of poultry, but the smallholder farmers who raise these birds face the challenge of improving the productivity of their flocks. Indigenous chickens are better adapted than commercial hybrid chickens to scavenging systems, where they are exposed to disease, food that is deficient in quantity and quality and poor housing and health care (Guèye, 1998; Kitalyi, 1998). To deal with these constraints and enhance productivity, a management intervention package is being disseminated to smallholder farmers by extension service providers. The package consists of feed supplementation, vaccination, brooder, chick rearing equipment and improved housing (Njue et al., 2006).

Many smallholder farmers with flock sizes of less than 50 chickens are unaware that they can improve their productivity if their household adopts the full package, which is designed for

integrated application, rather than selectively adopting some of its components. An analysis of the farmers' adoption behavior using principal component analysis (PCA) followed by cluster analysis revealed three homogeneous types of farmers: adopters of the full management intervention package as disseminated, adopters of feed supplementation and vaccination, and adopters of feed supplementation and brooder (Ochieng et al., 2010; Ochieng, 2011). The management interventions will only be sustainable if they suit the limited physical and economic resources of farming households (Aklilu, 2007). Farmers have not been able to adopt the full package despite relentless efforts by NGOs, government extension services and other agencies involved in rural development in Kenya.

This study sought to determine the socio-economic factors influencing the adoption behavior of the three farmer groups identified by PCA and cluster analysis: management intervention package adopters, feed supplementation and vaccination adopters, and feed supplementation and brooder adopters (Ochieng, 2011). This was done using the multinomial logit model (MNL). The findings of this study are expected to inform policymakers on appropriate strategies to increase adoption of the package in order to improve productivity and increase household income from indigenous chicken.

The rest of this paper is organized as follows. Section 2 describes the study area and explains the methodology, including the sampling techniques and hypothesized effects variables considered in the model; Section 3 explains the specification of the model and lists the variables used in the estimations, as discussed in Section 4; Section 4 presents and discusses the results; and Section 5 concludes and draws policy implications.

2. Methodology

2.1 Description of study area

The study was conducted in the Rongo and Homa Bay Districts of western Kenya, a region characterized by high poverty levels, with an estimated 54% of the households living below the poverty level (GoK, 2005). Homa Bay District stretches to the edge of Lake Victoria and is divided into six administrative divisions, Riana, Rangwe, Nyarongi, Asego, Kobama and Dhiwa, 26 locations and 63 sub-locations. Rongo District borders Homa Bay District to the north and north west and has a total area of 834 km^2. It is divided into three administrative divisions, Rongo, Uriri and Awendo (AW in Figure 1), 17 locations and 54 sub-locations (GoK, 2007). The region is prominent in indigenous chicken production. Indigenous chicken is a key source of food and income for rural farming households here, and extension services target the area in order to improve productivity and commercialization by encouraging adoption of the management intervention package.

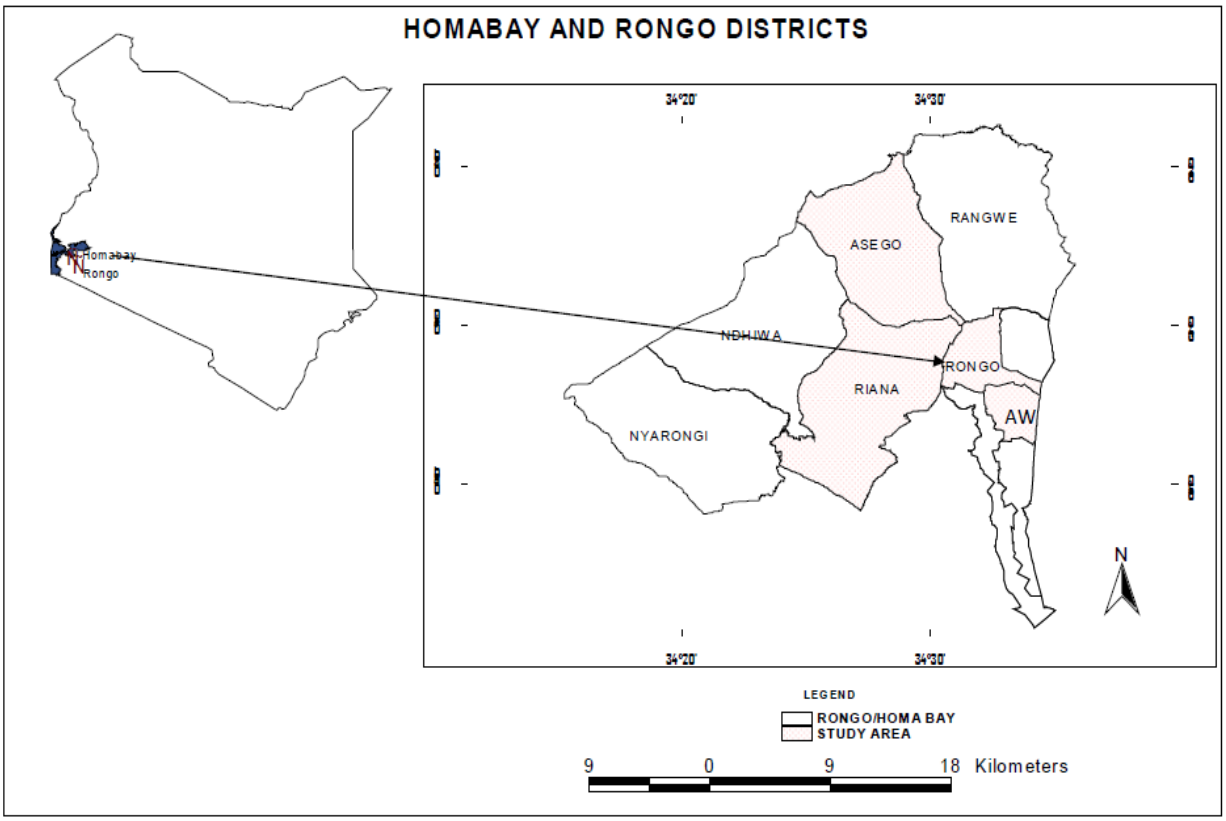

Figure 1: Map of the study area

2.2 Sampling design and techniques

The target population was smallholder farmers in the area who keep indigenous chickens. To obtain the sample, the study applied stratified random sampling by population density and indigenous chicken market prominence, based on local expert knowledge. In each district, two divisions were selected, one representing low indigenous chicken population density and low markets and the other representing high indigenous chicken population density and high markets. The four divisions that were chosen were Asego, Riana, Rongo and Awendo. The sampling frame was obtained from the list of farmers provided by Kenya Poultry Farmers Association (KEPOFA) and the Indigenous Chicken Farmers Association (ICFA) in the two districts. Application of simple random sampling yielded 30 farmers from each of the four divisions, giving a total of 120 smallholder farmers.

The study involved surveys of farm households using structured interviews to collect primary data: household composition, chicken production practices, socio-economic characteristics, chicken management interventions, access to extension services, credit, other sources of household income, and costs and revenues realized in the 2008 production period. Data collection was augmented by observation to validate the farmer's responses during farm visits.

2.3 Factors hypothesized to influence adoption of management interventions

The study assumed that selective adoption of the management intervention package was influenced by farm and farmer characteristics and institutional support factors. Therefore, the data collected through the structured interview schedule were farm, farmer and institutional characteristics. Questions about farm and farmer characteristics included issues such as experience in indigenous chicken production, education level, group membership, gender, off-farm income and distance to the market, and institutional characteristics captured extension services, credit and training.

Gender was expected to positively or negatively influence adoption of management interventions. Male farmers were expected to adopt the full package because they are normally more commercially motivated than their female counterparts. But female farmers were also expected to adopt the full package since they dominate indigenous chicken production in Africa, 80% of which is managed by women (Guèye, 1998). Educational level represents human capital captured by calculating the average years of completed schooling for each farmer. Production decision-making can be influenced by the level of education of household members. Farmers with a higher level of education were expected to adopt the full package as disseminated because literacy improves the ability to conceptualize information and make economically viable decisions.

Smallholder farmers with more years of experience tend to be less conservative and hence more likely to adopt the full package. On the other hand, less experienced farmers were expected to adopt components of the package selectively, which is not in line with the extension service recommendation. Farmers who belong to farmer groups have access to group credit, training, and easy access to extension from NGOs and government and were therefore expected to adopt the full package. These farmers embrace the spirit of collective action in order to benefit from group based vaccination, purchase of inputs and lobbying for good policies. Credit allows farmers to purchase inputs such as feeds, vaccines, drugs and materials for building chicken coops.

Smallholder farmers closer to the market were expected to adopt the full package, while those living further from the market were expected to modify and selectively adopt components of the package. Off-farm income was expected to positively influence the adoption of the full package. Farmers with off-farm income are less risk averse than those with none, since off-farm income mitigates the shortage of capital input. Smallholder farmers with lower off-farm incomes, or none, were expected to be more likely to selectively adopt and modify components of the package.

3. Analytical framework

The analysis in this study identified important determinants of adoption of the management intervention package. The analytical approaches commonly used in adoption decision studies involving multiple choices are the multinomial logit (MNL) and multinomial probit (MNP) models. MNL was preferred because of its computational simplicity compared to the MNP

model. It provides a convenient closed form for underlying choice probabilities without requiring multivariate integration, thereby making it simple to compute multiple choice situations. The MNL models relationships between polytomous response variables and set of regressor variables for both consumer and producer choices. The MNL is appropriate when the data consist of individual-specific characteristics (Greene, 2003). The explanatory variables, being characteristics of an individual, are constant over the alternatives in the choice set (Maddala, 1992; Greene, 2003).

Logistic regression analysis was used to determine and quantify the relations between the farmer's preference for particular components of the management intervention package and some hypothesized explanatory variables. This model was used mainly to test socio-economic characteristics that influence the farmers' preference for given components of the package. The characteristics were measured by off-farm income, membership of self-help group (social capital), distance to the market, education level in years of schooling, farmer's experience in years, gender, access to extension services and access to credit. In equation (1), X_i is a vector of explanatory variables, β_j is the matrix of parameters to be estimated and Y is the response variable, which was multiple in nature such that *Prob* (Y_i = j) is the probability of an individual farmer i having adopted a given component of management interventions j. A general formalization of the MNL, according to Schmidt and Strauss (1975), for the probability that individual farmer i chooses alternatives j and m is the number of alternatives expressed in equation (1):

$$\Pr ob\ (Y_i = j) = \frac{e^{\beta_j x_i}}{1 + \sum_{k=1}^{J} e^{\beta_k x_i}}, = j = 1, 2, ... J \qquad (1)$$

It is convenient to normalize the above model to solve the problem of indeterminacy by setting $\beta_0 = 0$. This arises because the probabilities sum to one, so only J parameter vectors are needed to determine J+1 probability. Therefore the probabilities are that:

$$\Pr ob\ (Y_i = j | x_i) = \frac{e^{\beta_j x_i}}{1 + \sum_{k=1}^{J} e^{\beta_k x_i}}, = j = 1, 2, ... J, \beta_0 = 0 \qquad (2)$$

The J log-odds ratio from equation (2) is shown in equation (3):

$$\ln\left(\frac{P_{ij}}{P_{ik}}\right) = x_i'(\beta_j - \beta_k) = x_i'(\beta_j), \text{ if } k=0 \quad (3)$$

The reduced linear form of the MNL model becomes:

$$Y = \beta_0 + \sum_{i=1}^{i} \beta_i X_i + \varepsilon \quad (4)$$

where Y is the probability that household i chooses management interventions j, β_0 is the intercept term, β_i, β_j and β_k are vectors of parameters to be estimated (each of which is different, even though X_i is constant across alternatives), X_i, are characteristics perceived to be influencing the pattern of adoption of management interventions and ε is the disturbance term, which is assumed to be logistically distributed. The coefficients in this model are difficult to interpret and associating the β_j and *jth* outcome is misleading (Greene, 2003). Therefore, marginal probabilities of choice (marginal effects) were obtained from the MNL results to facilitate interpretation of the results, as shown in equation (5):

$$\frac{\partial P_j}{\partial X_i} = P_j[\beta_j - \sum_{k=0}^{J} P_k \beta_k] = P_j[\beta_j - \bar{\beta}], j = 1,2,3....J \quad (5)$$

The marginal effects are the partial derivatives of probabilities with respect to individual-specific characteristics.

4. Results and discussion

Table 1 presents the estimated marginal effects for components of the management intervention package adopted by smallholder farmers in the study sample. The model log likelihood ratio X2 (84.455) is significant at the 1% level with 18 degrees of freedom, indicating that the explanatory variables included are significant in explaining the adoption of management interventions by the sampled farm households. The pseudo R^2 of 36.7% was above the statistical threshold of 20%, thus confirming that the adoption of management interventions could be attributed to the

covariates fitted. The empirical results indicate that education (-0.0527), distance to the market (0.1085), extension services (0.0631) and access to credit (-0.3037) significantly influenced the farmers' adoption of feed supplementation and brooder. The marginal effects (dy/dx) were significant at the 5% significance level.

Table 1: Marginal effects of factors that influence choice of management interventions

Variables	Adopted management interventions		
	Feed supplementation and brooder adopters	**Feed supplementation and vaccination adopters**	**Full package adopters**
Gender (female 1, male 0)	0.0546	0.1093	-0.1639*
Experience (years)	-0.0064	0.0015	0.0049
Education (years)	-0.0527***	0.0253*	0.0273**
Distance to market (km)	0.1085***	-0.0604**	-0.0484**
Group membership (member 1, otherwise 0)	-0.0424	0.2028**	0.2604**
Extension (access 1, otherwise 0)	0.06312***	0.4270***	0.2041*
Training (workshops, seminars) (access 1, otherwise 0)	-0.2453	0.0664	0.1789
Access to credit (access 1, otherwise 0)	-0.3037**	0.1623	0.1413
Off-farm income (Kshs)	-0.0192	-0.0746	0.0267**

Notes: Log likelihood -84.455, LR-chi-square 96.76 (df =18) and pseudo R^2 of 0.367, P-value= 0.000
***, significant at 1%, ** 5% and *10%

Gender was found to be the most important variable affecting the adoption decision. Male farmers were more likely to adopt the full package while women were more likely to adopt components of it, indicating that they were risk averse and thus unable to adopt the full package. This is because of the challenges faced by women farmers in accessing productive resources, especially as regards obtaining credit and access to land (Lastarria-Cornhiel, 2006). Women are often deprived of the rights and opportunities that men enjoy, and are denied access to financial and economic resources. The male farmers, however, who have easier access to economic resources, were risk takers and commercially motivated since most preferred to adopt the full package in order to increase indigenous chicken productivity and get more returns. Female- and male-headed households differ in their adoption behavior and this could be explained by their differences in access to income, assets, education and technologies.

Experience in indigenous chicken farming had a significant and positive marginal effect on adoption of the full package. A longer experience in indigenous chicken production increased the probability of adopting the full package, indicating that experienced farmers were more knowledgeable about the application of the full package as a way of increasing flock productivity. Teklewold et al. (2006) report that as farmers learn more about a technology through their own experience, the scale of adoption increases. However, the farmers with less experience were likely to adopt feed supplementation and vaccination only or feed supplementation and brooder only.

The sampled farmers' education level had a positive marginal effect on the adoption of feed supplementation and vaccination and the full package. Farmers with a lower education level were likely to adopt feed supplementation and brooder. A higher education level was expected to decrease risk aversion behavior and increase the rate of adoption. Being a farmer with a higher education level increased the likelihood of adopting the full package. This indicates that better education enables households to access and conceptualize information and profitably combine various management interventions. This result is in conformity with the findings of Karki and Bauer, (2004) and Agwu et al. (2008) who also report that higher education is advantageous for adoption of farm innovations and makes farmers more responsive to many agricultural extension programs and policies.

Farmer groups were important in influencing the adoption of the full package. This could be due to pooling of resources and easy access to extension through groups as well as reduction of information asymmetry. In addition, group veterinary services and access to credit were common among the indigenous chicken farmers who were group members. Farmers in groups mobilize their limited resources to carry out activities like group based vaccination and purchase of inputs such as drugs, feeds and equipment. Group membership had no effect on the adoption of feed supplementation and brooder since farmers in this category were using local feeds and local materials for making brooders. Purchases of drugs and vaccination of chickens were done in groups to save on cost and ensure proper timing.

Increased access to extension services increased the probability of adopting the full package. Farm households with limited access to extension services were more likely to adopt only feed supplementation and brooder. This implies that regular visits by an extension worker are necessary to enhance the adoption of management interventions because extension services provide information, knowledge and skills that enable farmers to apply interventions. Tecklewold et al. (2006) report that access to extension services influences the adoption of technology in chicken production but does not influence the farmer's decision to intensify the technology.

Distance to the market played a vital role in the adoption of management interventions. A decrease in distance to the market increases the probability of adopting the full package, while an increase reduces the probability of adopting feed supplementation and vaccination. This is because feed supplements and vaccines at cheap prices are only available in major markets such as Kisii, Homa Bay and Rongo. This means that poor market access for farmers located in remote places increases the transaction costs.

Off-farm income positively influenced adoption of the full package, indicating that off-farm income increases the likelihood of adopting the full package by mitigating the shortage of capital input. Thirtle et al. (2003) report that households without off-farm income are likely to be risk averse. The adoption of the full package was more likely in cases of larger amounts of off-farm income, which also influenced the availability of labor for production and household wealth that could be diverted into chicken production activities. Lower off-farm income earners were likely to selectively adopt components of the package since they used their small incomes for household subsistence purposes before spending the remainder on chicken production. Farmers' off-farm incomes were mainly derived from the sale of assets, remittances and formal and informal employment.

Access to credit, however, was not at all significant for the adoption of the full package and access to credit in fact reduced the probability of adopting feed supplementation and brooder because farmers mainly rely on locally available feeds and brooding materials. This could be because of the fungibility of credit. This implies that it would be better to disburse credit in the form of inputs rather than cash in order to realize the intended benefits.

5. Conclusions and policy implications

Despite the potential of indigenous chicken farming for reducing poverty in Kenya, the recommended management interventions to increase productivity have not been fully adopted by smallholder farmers. Adoption of the management intervention package was influenced by gender, farmer's experience, farmer's education level, membership of self-help groups, access to extension programs, distance to the market and off-farm income. The policy recommendation, therefore, is that the government and development partners should design a management intervention adoption program based on the demographic and socio-economic conditions of smallholder farmers to increase indigenous chicken productivity. The program should encourage the formation of self-help groups and create awareness through training. Micro-credit providers should provide credit in the form of inputs in order to encourage adoption of the management intervention package. These steps would lead to increased productivity and higher incomes for smallholder farmers of indigenous chicken in rural Kenya.

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References

Agwu, AE, Ekwueme, JN & Anyanwu, AC, 2008. Adoption of improved agricultural technologies disseminated via radio programme by farmers in Enugu state, Nigeria. African Journal of Biotechnology 7(9), 1277–86.

Aklilu, AH, 2007. Village poultry in Ethiopia. Socio-technical analysis and learning with farmers. Published PhD thesis, Wageningen University, Wageningen, The Netherlands.

Delgado, CL, Mark, WR & Meyer, S, 2001. Livestock revolution to 2020: The revolution continues. Annual meeting of the International Agricultural Trade Research Consortium (ATRC), 18–19 January, Auckland, New Zealand.

GoK (Government of Kenya), 2005. Geographic Dimensions of Well-Being in Kenya: Who and Where are the Poor? A Constituency Level Profile, Vol. II. Central Bureau of Statistics, Ministry of Planning and National Development, Nairobi, Kenya.

GoK (Government of Kenya), 2007. Kenya Integrated Household Budget Survey (KIHBS) 2005/06. Volume 1. Basic Report. Nairobi, Kenya.

GoK (Government of Kenya), 2008. National Poultry Policy, Draft 1, December. Department of Livestock Production, Ministry of Livestock Development, Nairobi, Kenya.

Greene, WH, 2003. Econometric Analysis. Fifth Edition. Pearson Education International, Upper Saddle River, NJ.

Guèye, EF, 1998. Village egg and fowl meat production in Africa. World's Poultry Science Journal 54, 73–86.

Karki, LB & Bauer, S, 2004. Technology adoption and household food security: Analyzing factors determining adoption and impact of project intervention. A case of smallholder peasants in Nepal. Paper presented at the Deutscher Tropentag, 5–7 October, Humboldt University, Berlin. www.tropentag.de/2004/abstracts/full/107.pdf Accessed 19 November 2009.

Kitalyi, AJ, 1998. Village chicken production systems in Africa. Animal Production and Health Bulletin 142, Food and Agricultural Organization (FAO), Rome, Italy.

Lastarria-Cornhiel, S, 2006. Feminization of agriculture: Trends and driving forces. Background paper for the World Development Report, 2008, Agriculture for Development. www.rimisp.org/getdoc.php?docid=6489 Accessed 15 August 2011.

Maddala, GS, 1992. Introduction to Econometrics. Second edition, Macmillan, New York.

Njue, SW, Kasiiti, JL & Gacheru, SG, 2006. Assessing the economic impact of commercial poultry feeds supplementation and vaccination against Newcastle disease in local chicken in Kenya. Proceedings of a final research coordination meeting organized by the Joint FAO (Food and Agriculture Organization) / /IAEA (International Atomic Energy Agency), 24–28 May, Vienna. www-pub.iaea.org/mtcd/publications/pdf/te_1489_web.pdf Accessed 21 October 2012.

Ochieng, J, 2011. Management Interventions and Indigenous Chicken Productivity: The case of Smallholder Farmers in Western Kenya. Lap Lambert Academic Publishing, Saarbrücken, Germany.

Ochieng, J, Owuor, G & Bebe, BO, 2010. Pattern of Management Interventions' Adoption and their Effect on Productivity of Indigenous Chicken in Kenya. Proceedings of 2010 CAER (China Agricultural Economic Review) / IFPRI (International Food Policy Research

Institute) International Annual Conference on Agriculture and Wealth of Nations, 16–17 October, Beijing.

Schmidt, P & Strauss, RP, 1975. The prediction of occupations using mode multiple logit models. International Economic Review 16(2), 471–86.

Tadelle, D, Alemu, Y & Peters, KJ, 2000. Indigenous chicken in Ethiopia: Genetic potential and attempts at improvement. World's Poultry Science Journal 56, 45–54.

Teklewold, HT, Dadi L, Yami, A & Dana, N, 2006. Determinants of adoption of poultry technology: A double-hurdle approach. Livestock Research for Rural Development 818(3). www.lrrd.org/lrrd18/3/tekl18040.htm Accessed 21 October 2012.

Thirtle, C, Beyers, L, Ismael, Y & Piesse, J, 2003. Can GM-technologies help the poor? The impact of Bt-cotton in Makhathini Flats, Kwazulu-Natal. World Development 31(4), 717–32.