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Drivers of commercialization: A case of indigenous chicken production in northern Uganda

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This study was conducted to assess the drivers of commercialization and profitability among the smallholder farmers of indigenous chickens (IC) in northern Uganda. A market index was constructed to measure the proportion of IC marketed as a proxy for commercialization. A Tobit regression model was fitted using maximum likelihood estimation to determine the drivers of commercialization level of IC. Gross margin analysis was conducted to measure annual profits from IC production and a multiple linear regression was estimated using ordinary least squares to ascertain the determinants of profitability. Overall, the level of commercialization of IC was found to be as low as 31.2%. This level was affected by: IC flock size, number of cattle owned, group membership and access to poultry specific extension services. Commercial IC production was found to be profitable with average gross margins of UGX 118,704 (equivalent to US$34 per annum). Our results revealed that profitability in IC production and marketing was affected by bicycle access, number of extension visits, family ownership of chickens, sex, and age of household head. Our findings point to the need for implementation of strategies to increase flock size like disease management, provision of targeted extension services and increased group marketing of chickens.

Keywords: commercialization, indigenous chickens, profitability, Uganda

Introduction

Chickens constitute the most widespread livestock species reared in the world (Perry et al. 2002; Moreki, Dikeme, and Poroga 2010) with the highest proportion (71.6%) of the world's chicken population (16.2 billion) found in developing countries (Bushra 2012). Along with other poultry species, chickens account for 30% of meat consumed globally (FAO 2010). In line with this, global per capita consumption of poultry meat has increased fourfold in under fifty years, from 3 kg in 1963 to 11 kg in 2003 (FAOSTAT 2009). In Uganda, indigenous chickens (IC) (*Gallus domesticus L.)* are found in almost all rural households and are kept mainly for subsistence purposes while exotic breeds are reared by a few market-oriented households for commercial purposes. Over the past decade, there has been a rise in poultry production and the national poultry flock which includes both indigenous and exotic breeds increased from 42.7 million birds in 2010 to 44.7 million in 2014. Egg production has also increased from 761.3 million units in 2010 to 856 million units in 2014 (UBOS 2015) (Table 1). With increased domestic poultry production, Uganda is poised to limit importation of poultry, especially chicken and chicken products, thus saving millions of dollars.

Of the 44.7 million birds, chickens dominate the industry with 86% of the chickens being IC, thus showing its dominance in the sector (UBOS 2015). This continued dominance of IC despite the introduction of exotic breeds can be attributed to their traits such as high resistance to diseases, high tolerance to heat and cold, better scavenging abilities, good mothering ability and defence of young ones against predators (King'ori, Wachira, and Tuitoek 2010; Bushra 2012). Additionally, IC are often associated with good quality eggs and meat flavour, hard egg shells (hence a longer shelf-life), high dressing percentages and low production costs (Gueye 1998). Therefore, due to their dominance, IC have the capacity to form the base for improved rural poultry production and attain commercial status, thus increasing food security and income in poor rural homes (Kyarisiima, Kugonza, and Twesigye 2004).

Pingali and Rosegrant (1995) pointed out that agricultural commercialization is a transformation process from subsistence to semi-commercial then to fully commercialized agriculture. Transition from subsistence to commercial agriculture is a necessary pathway towards economic growth and development for agriculture dependent developing countries (World Bank 2008). Among livestock-based enterprises, poultry production has assumed an important role as a commercial activity with enormous potential for rapid economic growth (Ekunwe, Soniregun, and Oyedeji 2006). Commercialization entails both market orientation and market participation. Market orientation refers to the degree of allocation of resources (land, labour and capital) to production of agricultural produce that are meant for exchange or sale (Immink and Alarcon 1993). This means decisions regarding production are based on market signals. While market participation on the other hand refers to the proportion of produce offered for sale and the use of purchased inputs in production (Gebremedhin and Jaleta 2010). In this study, commercialization was specifically looked at in terms of market participation, that is, the proportion of sales of agricultural produce or livestock to earn income. Thus, commercialization in this study was measured by the proportion of IC marketed out of the total number of IC produced by individual households per annum. Whereas there is a need to shift from subsistence to commercial production, it requires better management levels in terms of production and marketing of agricultural output.

Table 1: Poultry population and egg production in Uganda, 2010–2014.

Year	Indigenous (millions)	Exotic (millions)	Eggs (millions)
2010	40.4	2.9	761.3
2011	35.9	5.0	784.1
2012	36.9	5.2	807.6
2013	38.1	5.3	831.9
2014	39.2	5.5	856.8

***Source*:** Uganda Bureau of Statistics (UBOS 2015)

Sustainable household food security and welfare also requires commercial transformation of subsistence agriculture (Gebremedhin and Jaleta 2010). The decision to commercialize IC production is dependent on various factors including socioeconomic factors such as age, experience in IC production, education level; institutional factors such as availability of markets, access to extension services, belonging to a group, road infrastructure; and market-related factors such as access to markets measured by distance to nearest markets. All these affect a farmer's decision on whether to commercialize or not. The more sales of chickens a farmer makes (hence, the more commercialized), the greater the profit he or she is likely to make, keeping other factors constant (Ayieko, Bett, and Kabuage 2014).

In northern Uganda, IC production has been recognized as an avenue to improve livelihoods and eradicate poverty in rural households, where IC provide meat, eggs and income (Nakkazi et al. 2014). Transforming its production from subsistence to commercial levels will increase food security and income in poor rural households (Kyarisiima, Kugonza, and Twesigye 2004), and meet unmet market demand for poultry and poultry products (Ondwasy, Wesonga, and Okitoi 2006). However, there are few studies showing the driving factors for smallholder farmers to commercialize their production. Although studies from elsewhere show that commercial IC production is profitable (Menge, Kosgey, and Kahi 2005; Natukunda, Kugonza, and Kyarisiima 2011; Oladeebo and Ojo 2012; Ayieko, Bett, and Kabuage 2014), it is not certain whether it is profitable in northern Uganda. The study was therefore motivated to determine the drivers of commercialization and ascertain the area-specific factors responsible for profitability of the commercializing smallholder IC producers in the studied region.

Methodology

Study areas

Omoro district is a newly created district from Gulu district, located north of Uganda's capital city, Kampala. Omoro district is bordered by Gulu district to the north, Oyam district to the south, Pader district to the east and Nwoya district to the west. The district consists of six sub-counties and one town council, Omoro town council. Omoro district has a total land area of 1,581 km^2 and had a total population of 165,642 people in 2014 with an annual growth rate of 3.3% and a population density of 105 persons per km^2.

Oyam district is situated between latitudes 2° N and 2° 7′ N and longitudes 32°2′ E and 32°10′ E. The district covers a total area of approximately 2,207 km^2. The district is made up of seven sub-counties and one town council. The total number of households was 77,435 as of 2014 with average household size of 5.0 and population growth rate of 3.07% (UBOS 2014).

Research design and sampling procedure

A cross-sectional household survey was carried out and a multi-stage sampling procedure was used to select respondents. Purposive sampling was used to select districts and sub-counties that ranked highest in terms of number of IC. Thus, in Omoro district, Bobi and Lalogi sub-counties ranked highest and in Oyam district, Loro and Minakulu sub-counties ranked highest. Respondents were randomly selected from a sample frame of IC farming households that sell their chickens at least once a year and at least have one-year experience in IC production. This gave a total of 180 respondents. Pre-tested questionnaires were used to collect primary data. Secondary data were obtained from District Agricultural and Veterinary Offices and Uganda Bureau of Statistics.

Empirical approach

Analysis on level of commercialization of indigenous chicken production

Commercialization level was determined using a market index (MI) measured by the proportion of IC sold out of the total produced by a given household per annum (Govereh, Jayne, and Nyoro 1999; Strasberg et al. 1999; Osmani et al. 2014). The market index (MI) was formulated in the following way:

$$MI_i = \frac{\begin{array}{c}\text{Gross value of indigenous chicken}\\ \text{sales by ith household in year } j\end{array}}{\begin{array}{c}\text{Gross value of all indigenous chickens}\\ \text{produced by ith household in year } j\end{array}} \times 100\% \quad (1)$$

where MI$_i$ refers to extent of the i^{th} household's commercialization level. This index measures the ratio of gross value of IC sales by the i^{th} household in year j to gross value of all IC produced by the same household in the same year. That is, it measures the degree to which a household sells its IC. If the index is zero, it would signify a totally subsistence-oriented household and if the index is 100%, it would signify a purely commercial household.

A Tobit regression model was used to analyze factors affecting commercialization level since commercialization level has both lower and upper limits (commercialization level values range from 0–1). Following Wooldridge

(2003) and Cameron and Trivedi (2005), the Tobit regression was modified for analysis of commercialization level as below:

$$C_{ij}^{*} = X_{ij}\beta + \mu_i \quad (2)$$

where $C_{ij} = 0$ if $C_{ij} < 0$; $C_{ij} = C_{ij}^{*}$ if $0 \leq C_{ij}^{*} \leq 1$; $C_{ij} = 1$ if $C_{ij} > 1$.

C_{ij} is a latent variable representing commercialization level scores of households keeping j^{th} number of chickens. These commercialization scores take on a minimum value of zero (0) and a maximum value of one (1). X_{ij} is a vector of explanatory variables which affect commercialization of IC for the i^{th} IC farmer. These include age, number of school-going children, access to poultry extension services, number of cattle owned, belonging to a group, transport hire, sale at market place, husband's decision to sell chickens and IC flock size. β is a vector of parameters to be estimated associated with commercial IC production. These parameters of the Tobit model were estimated using method of maximum likelihood estimation (MLE) using STATA version 13.

Multicollinearity, omitted variable test, correlation matrix of independent variables and variance inflationary factor were performed on the model. Results of these tests turned out negative for multicollinearity, omitted variables and variance inflationary factor, implying the model and variables chosen were adequate.

Analysis of profitability and its determinants

The gross margin analysis was used to determine profits obtained from IC sales. The profit function gives profit (π) when cost is deducted from revenue. Profit, cost and revenue functions are related by the formula:

$$\pi_i = R_i - C_i \quad (3)$$

where π_i is profit per farmer per year for the i^{th} household, R_i is revenue per farmer per year for the i^{th} household and C_i is cost per farmer per year for the i^{th} household.

Revenues (R) were calculated using the equation:

$$R_i = R_{\text{eggs}} + R_{\text{pullets}} + R_{\text{cockerels}} + R_{\text{cocks}} + R_{\text{hens}} \quad (4)$$

where R_{eggs} is revenue from sale of eggs, R_{pullets} is revenue from sale of pullets, $R_{\text{cockerels}}$ is revenue from sale of cockerels, R_{cocks} is revenue from sale of cocks and R_{hens} is revenue from sale of hens.

The revenue function gives total revenue from sale of X chickens/eggs. Revenue was computed as:

$$R_i = PX \quad (5)$$

where R is revenue, P is price per chicken/egg and X is number of chickens/eggs.

Costs (C) were derived from the following equation:

$$C_i = C_F + C_V + C_M \quad (6)$$

where C_F is total cost of feeds for the entire flock, C_V is veterinary costs of vaccination, C_M is marketing costs involving transport and market levy costs.

To estimate significance of determinants of profitability, a multiple linear regressing model was applied using method of ordinary least squares (OLS). OLS is used when the dependent variable is continuous (Wooldridge 2003), so it was adopted in this study since gross margin per farmer, being the dependent variable, is continuous. Annual gross margin per farmer was obtained by subtracting annual variable costs from annual revenue and it was measured in Uganda shillings (UGX). Independent variables included sex of respondent, age of household head, bicycle access, number of extension visits, family ownership of chickens, belonging to a group and market distance. A constant, α indicates profit or loss a farmer would make per bird holding other determinants constant. Error term, μ was included in the model to account for determinants that were not included but could affect level of profits.

Multicollinearity, variance inflationary factor and heteroscedasticity tests were performed on the model. Results of the tests turned out negative for multicollinearity and variance inflationary factor implying that the model and variables chosen were adequate. However, heteroscedasticity was positive but corrected using robust regression.

A multiple Linear Regression Model of determinants of profitability was specified as below:

$$GM = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \mu \quad (7)$$

where GM = gross margin per farmer (Uganda Shillings/UGX) and α = constant (intercept).

Gross margin was expected to change by a certain factor, β (coefficient) if any of the above variables increased by one unit.

Results

Commercialization level of indigenous chicken farmers in Omoro and Oyam districts

Indigenous chicken farmers were grouped depending on the proportion of IC sold out of the total number of IC produced per year. The majority (85%) of IC farmers had less than a 50% level of commercialization, implying they sold less than 50% of the total IC they produced in a year. Only 15% of the IC farmers sold over 50% of the total IC they produced. Comparing the districts, Omoro district had more farmers selling less than 50% of their IC produced compared to their counterparts in Oyam. More farmers in Oyam district sold more than 50% of their IC produced (Table 2).

Indigenous chicken flock sizes

Overall, the average annual household flock size was 83 chickens consisting of 36 chicks, 15 cockerels, 15 pullets, 10 hens and 7 cocks. In Oyam, the average annual flock size was 72 chickens consisting of 30 chicks, 14 cockerels, 14 pullets, 8 hens and 6 cocks while in Omoro, average annual flock size was 93 chickens consisting of 41 chicks, 15 cockerels, 17 pullets, 11

Table 2: Level of commercialization of indigenous chicken farmers in Omoro and Oyam districts.

	Percent		
Level of commercialization	Overall	Omoro	Oyam
Less than 50%	85	86.46	83.33
Above 50%	15	13.54	16.67

***Source*:** Survey data (2017)

hens and 8 cocks. Flock sizes between the two districts were significantly different ($p < 0.05$) with Omoro flock sizes being higher than Oyam flock sizes (Table 3).

Level of commercialization of indigenous chickens and their products

Overall, the annual egg sales per household was 14 eggs with annual egg sales in Oyam district (25 eggs) being significantly higher ($p < 0.1$) than annual egg sales in Omoro district (4 eggs). There was a very negligible proportion of chicks sold across the board (0.5%). Although there were no chick sales in Oyam, there was no significant difference in the proportion of chicks sold between Oyam and Omoro districts (0.9%). The percentage of chickens sold per household was 31.2% on average in Oyam and Omoro districts. In Oyam, the percentage of chickens sold was 33.5% while in Omoro, it was 29.1%. However, the level of sales in the two locations did not significantly differ. Average percentage of pullets sold per household was 35.2% of annual production. However, farmers in Oyam sold significantly more ($p < 0.1$) pullets than their counterparts in Omoro. Of the total annual household cockerel production, 38.3% was sold. However, there was a non-significant difference in cockerel sales between Oyam and Omoro districts. Average percentage of hens sold per household was the least at 23.7% of total annual production. Level of sale of hens between the two districts was not significantly different. Average percentage of cocks sold per household was the highest at 58.1% of total annual production. Although households in Omoro sold more cocks than households in Oyam, this difference was not significant (Table 4).

Determinants of commercialization of indigenous chicken production in Omoro and Oyam districts, northern Uganda

The overall Tobit model was found to be adequate as shown by summary statistics. The Prob>F and Prob>chi^2 are highly significant. Multicollinearity test was performed on the model and the result turned out negative. Twenty one out of 180 observations were not within limits specified. Thus, 17 observations were left censored, implying that 17 farmers interviewed do not sell their chickens, while 4 observations were right censored implying, that 4 farmers interviewed sold more chickens than they produced. These observations may have occurred due to the failure of farmers to recall their production and marketing statistics.

IC flock size of a household was found to positively and significantly ($p < 0.05$) affect commercialization level of IC production. Results show that a unit increase in flock size resulted in 0.07% increase in proportion of IC marketed. A husband's decision to sell IC was found to positively and significantly ($p < 0.05$) associated with commercialization level of IC production. Number of cattle possessed by a household was found to positively and significantly ($p < 0.05$) related to IC production. A unit increase in number of cattle increased commercialization level by 1.12%. Number of school-going children in a household was unexpectedly found to negatively and significantly ($p < 0.1$) affect commercialization level of IC production. A unit increase in number of school-going children in a household decreased commercialization level by 1.53%. Involvement in group activities by farmers such as group marketing, farming and savings positively and significantly ($p < 0.1$) influenced commercialization level of IC. Results show that an increase in group involvement by a farmer increased commercialization level of IC by 7.34%. However, provision of poultry extension services was found to negatively affect ($p < 0.05$) commercialization level of IC (Table 5).

Gross margin, revenues and costs of indigenous chicken production

On average, overall total revenue obtained annually by a household was 266,482.2 UGX (US$76.14). There was a non-significant difference between total revenue obtained by farmers in Oyam and Omoro. Overall mean variable cost incurred by each household was 144,255.8 UGX (US$ 41.23). Variable cost incurred was significantly ($p < 0.1$) different between famers in Oyam and Omoro districts. Average gross margin was 118,704

Table 3: *t*-test of annual flock size of indigenous chickens in Omoro and Oyam districts.

Variable	Overall ($n = 180$)	Omoro ($n = 96$)	Oyam ($n = 84$)	Mean diff	*p*-value
Chicks	35.989(3.356)	41.083(5.709)	30.167(2.950)	10.917(6.697)*	0.0524
Cockerels	14.589(1.171)	15.260(1.812)	13.821(1.424)	1.439(2.351)	0.2706
Pullets	15.206(1.370)	16.594(2.337)	13.619(1.216)	2.975(2.746)	0.1400
Hens	10.017(1.130)	11.365(1.983)	8.476(0.837)	2.888(2.261)	0.1015
Cocks	7.383(0.722)	8.448(1.244)	6.167(0.593)	2.281(1.440)*	0.0577
Overall	83.183(6.046)	92.750(10.230)	75.250(5.412)	20.50(12.055)**	0.0454

***, ** and * imply coefficients statistically significant at 1%, 5% and 10%, respectively.
Figures in parentheses are standard errors.
***Source*:** Survey data (2017)

Table 4: *t*-tests of level of commercialization of indigenous chickens and products in Omoro and Oyam districts, northern Uganda.

Variable	Overall ($n = 180$)	Omoro ($n = 96$)	Oyam ($n = 84$)	Mean diff.	*p*-value
Annual egg sales	14.022	4.104	25.357	−21.253*	0.0538
	(6.585)	(3.385)	(13.510)	(13.141)	
Chick proportion sold	0.005	0.009	0	0.009	0.1658
	(0.004)	(0.008)	(0)	(0.009)	
Cockerel proportion sold	0.383	0.361	0.409	−0.049	0.2198
	(0.031)	(0.044)	(0.045)	(0.063)	
Pullet proportion sold	0.352	0.233	0.489	−0.256*	0.0905
	(0.095)	(0.036)	(0.200)	(0.191)	
Hen proportion sold	0.237	0.229	0.247	−0.018	0.3928
	(0.032)	(0.037)	(0.055)	(0.065)	
Cock proportion sold	0.581	0.625	0.530	0.095	0.1762
	(0.051)	(0.077)	(0.064)	(0.102)	
Overall chicken proportion sold	0.312	0.291	0.335	−0.044	0.1878
	(0.025)	(0.024)	(0.045)	(0.049)	

***, ** and * imply coefficients statistically significant at 1%, 5% and 10%, respectively. Figures in parentheses are standard errors.
***Source*:** Survey data (2017)

UGX (US$ 33.92) and was significantly ($p < 0.05$) different between Oyam and Omoro districts (Table 6).

Factors affecting profitability of commercial indigenous chicken production in Omoro and Oyam districts, northern Uganda

A multi-linear regression was run using ordinary least squares (OLS) method to identify factors that affect profitability of commercial IC production. The model was found to be adequate as shown by summary statistics. The F-statistics were found to be highly significant ($p < 0.01$). Multicollinearity test was performed on the model and the result turned out negative.

Access to bicycles for transportation of IC for sale was found to positively and significantly ($p < 0.01$) influence profitability of commercial IC production. This result showed that an increase in bicycle access by one bicycle increases gross margin by 4.920. Numbers of extension visits positively and significantly ($p < 0.01$) affected profitability of commercial IC production. The higher the number of extension visits per household, the higher the gross margins and hence increased profitability. Family ownership of IC was found to significantly ($p < 0.01$) and positively affect profitability of commercial IC production. Sex of the respondent significantly ($p < 0.1$) and positively influenced profitability of commercial IC production. Being male increased the gross margin of IC sales by 1.662, keeping all other factors constant. Age of household head significantly ($p < 0.1$) and negatively affected profitability of commercial IC production. Increase in age decreased profitability of commercial IC production by 0.001, keeping all other factors constant. Involvement in a group, especially a farming group, was found to be positively and significantly ($p < 0.1$) related to profitability of IC.

Discussion

From Table 2, a higher proportion of farmers in Oyam district sold more than 50% of the IC they produced compared to their counterparts in Omoro district. This means that farmers in Oyam were more commercialized than farmers in Omoro district. Perhaps this can be explained by many of the farmers in Oyam regarding commercial IC production as an important source of income. Overall, this emphasizes the low commercialization level of IC in northern Uganda (Demeke and Haji 2017).

Flock sizes in Omoro and Oyam districts significantly differed ($p < 0.05$) with Omoro flock sizes being bigger than Oyam flock sizes but were within flock size range of 3–113 reported by Ssewannyana et al. (2001). However, they are bigger than the Ugandan flock size range of 5–40 (Kyarisiima, Kugonza, and Twesigye 2004) and flock size of 32 ± 2 birds per household (Nakkazi et al. 2014) found within the same geographical region (Table 3).

The majority of IC farmers in Omoro and Oyam districts do not sell their IC eggs. Eggs are mainly used for hatching/reproduction. There was a very negligible proportion of chicks sold (0.5%) because chicks are usually left to grow and replace mature chickens previously sold.

The trend of chicken sales signifies the importance of cocks and cockerels in generating income. Most farmers prefer selling cocks and cockerels that fetch higher prices than hens and pullets that are, instead, preferred for reproduction and household consumption (Mlozi et al. 2003). The level of commercialization (31.2%) reported in this study shows that IC farmers in Oyam and Omoro districts are transitioning (commercializing) but are yet to become fully commercialized (Demeke and Haji 2017). This is because this level is below 50% which is the threshold for fully commercialized farmers (World Bank 2008). IC farmers in Omoro and Oyam districts of northern Uganda are in a transition process from subsistence to commercializing, and are currently in a semi-commercial state, and will finally transform into commercial farmers (Table 4).

The results show that a unit increase in flock size would result in 0.07% increase in the proportion of IC marketed. This result is similar to that in a study by Omiti et al. (2009) who found that the quantity of output produced has a positive and significant effect on the proportion of output sold. This finding also resonates with the findings of Lubungu, Chapoto, and Gelson (2012) in a study among smallholder livestock farmers in Zambia. They found that as livestock size of a household increases, the proportion taken to the market also increases.

Table 5: Tobit regression of determinants of indigenous chicken commercialization level.

	Tobit		Robust	
Variables	Coef. (SE)	$P>\|t\|$	Coef. (SE)	$P>\|t\|$
Age of respondent	0.0015(0.0013)	0.254	0.0015(0.0017)	0.355
Number of school-going children	−0.0153(0.0087)*	0.080	−0.0153(0.0084)*	0.071
Number of cattle owned	0.0112(0.0045)**	0.013	0.0112(0.0044)**	0.012
Indigenous chicken flock size	0.0007(0.0002)***	0.002	0.0007(0.0003)**	0.021
Husband's decision to sell chicken	0.0811(0.0446)*	0.070	0.0811(0.0425)*	0.058
Group involvement	0.0734(0.0387)*	0.060	0.0734(0.0398)*	0.067
Poultry extension services	−0.0960(0.0479)**	0.047	−0.0960(0.0479)**	0.046
Selling chickens at markets	0.0279(0.0380)	0.464	0.0279(0.0382)	0.466
Bicycle hire for chicken transport	−0.0660(0.1490)	0.658	−0.0660(0.1256)	0.600
Constant	0.0783(0.0757)	0.302	0.0783(0.0794)	0.325
Log likelihood	−21.5813		−21.5813	
F(9, 171)			2.82	
Prob > F			0.0041	
Prob > chi^2	0.0015			
LR chi^2 (9)	26.78			
Pseudo R_2	0.3829		0.3829	
N	180			
Left censored observations	17			
Uncensored observations	159			
Right censored observations	4			

***, ** and * imply coefficients statistically significant at 1%, 5% and 10%, respectively.
Figures in parentheses are standard errors
***Source*:** Survey data (2017)

Gebregziabher (2010) observed a similar effect in market chain analysis in the Tigray region where it was found that flock size positively affected value of poultry sales. This suggests that households with larger IC flock sizes are more likely to sell more IC than those with smaller flock sizes (Table 5).

A husband's decision to sell IC positively affected commercialization level. This could be due to the fact that in an African setting, men are usually entitled to ownership of resources in a home so their decisions regarding resources are always vital and implemented (Omiti et al. 2009). Although women are usually involved in production, it is predominantly the role of men to decide on sales and other marketing decisions regarding IC. This greatly affects the commercialization level of IC. This could also be attributed to the fact that men are more market-oriented than women, and therefore their decisions regarding IC production are more likely to favour an increase in commercialization level of IC (Martey, Ramatu, and Kuwornu 2012; Sigei, Bett, and Kibet 2014) (Table 5).

A unit increase in the number of cattle increased commercialization level by 1.12%. This could be attributed to barter trade practised in Acholi and Lango sub-regions where a bull, cow or heifer can be exchanged for a certain number of chickens. This result is similar to the findings of Kugonza, Kyarisiima, and Iisa (2008) who reported that in Teso sub-region of Uganda, IC are usually exchanged for other livestock such as cattle and goats, which, to a great extent, helps IC farmers move up the wealth ladder and eventually away from poverty. Thus, an increase in the number of cattle in a household could be as a result of an increase in the proportion of IC marketed. Additionally, the FAO (2009) reported that IC are usually exchanged in informal markets for larger animals such as goats and cattle. This also explains why such barter trade results in increased level of IC commercialization (Table 5).

A unit increase in the number of school-going children in a household decreases the level of commercialization by 1.53%. This shows that an increase in the number of school-going children decreases commercialization level of IC. This negative correlation between number of school-going children and commercialization level was contrary to apriori expectations. An increase in the number of school-going children was expected to increase the commercialization level because farmers were expected to sell their chickens to support the scholastic needs of their children. A study conducted by Cassian (2013) in Iringa district, Tanzania showed that many

Table 6: Comparing annual gross margins, revenues and costs of indigenous chicken production across districts.

Variable	Overall mean ($n=180$)	Mean Oyam ($n=84$)	Mean Omoro ($n=96$)	Mean difference
Total revenue	266482.2	235511.9	293581.3	58069.4
	(365370)	(42231.4)	(57760.2)	(73313.22)
Variable Cost	144255.8	199958.4	95516.2	−104442.2
	(37154.7)	(77893.1)	(13607.5)	(74272.63)*
Gross Margin	118704.2	31232.1	195242.2	164010.1
	(45490.5)	(78040.9)	(50227.9)	(90609.49)**

***, ** and * imply coefficients statistically significant at 1%, 5% and 10%, respectively. Figures in parentheses are standard errors.
***Source*:** Survey data (2017)

farmers commercialize their food crop production to be able to meet expenditure such as children's school fees. Thus, an increase in the number of school-going children was expected to increase commercialization level. However, this was not the case in either Oyam or Omoro districts, possibly because children mostly attend government-funded universal primary education (UPE) schools, for which parents do not have to pay (Table 5).

An increase in group involvement by a farmer was found to increase commercialization level of IC by 7.34%. Group involvement such as group marketing enables farmers to pull their resources together and take advantage of economies of scale such as transportation and marketing of larger numbers of chickens as a result of social capital created. Poulton, Kydd, and Dorward (2006) argued that belonging to a group empowers farmers to bargain and negotiate for better trading terms, thus increasing commercialization level of IC. Additionally, group involvements increase a household's access to information vital to production and marketing decisions (Olwande and Mathenge 2012). Access to reliable information such as market information improves agricultural commercialization (Omiti et al. 2009). This gives farmers a good understanding of market variation in terms of supply, demand and prices and hence they are able to make informed decisions regarding chicken sales (Table 5).

The negative effect of poultry extension services could probably be explained by the fact that in regard to the Plan for Modernization of Agriculture (PMA), the focus of agricultural extension has been on training farmers in production and marketing of commercial birds, mainly broilers and layers, which is an initiative of the Ugandan government. Therefore, extension agents have put major emphasis on commercial birds which has negatively impacted the commercialization level of IC (Table 5).

Generally, commercial IC production was profitable although profits obtained in Omoro district were significantly ($p < 0.05$) higher than profits obtained in Oyam district (Table 6). This difference could be attributed to the fact that Omoro district is nearer to Gulu town where chicken prices are much higher than in Omoro and Oyam districts. This is consistent with the finding of Tung and Costales (2007) who emphasized that geographical location largely affects market access in relation to main market centres. Access to main market centres, which offer better and higher prices for IC, increases the gross margins obtained from the sale of the chickens. This finding is also related to the findings of Abeykoon, Weerahewa, and Silva (2015) whose study showed that the value of poultry sales differed among villages in Sri Lanka. They argued that high market accessibility might be a reason for increased sales in particular villages.

Access to bicycles for transportation of IC for sale was found to significantly ($p < 0.01$) and positively influence profitability of commercial IC production. Bicycle access plays a crucial role in boosting the number of IC transported to the market which, in turn, brings about higher gross margins. Additionally, bicycle access lowers the cost of transportation which would be higher in cases where vehicles or motorcycles were used for transportation. Thus, bicycle access minimizes costs resulting in higher gross margins and profitability. This finding concurs with the study by Jagwe, Machethe, and Ouma (2010) on the impact of transaction cost on the participation of smallholder farmers and intermediaries in the banana market of Burundi, Rwanda and Democratic Republic of Congo. They found that the ownership of bicycles increased banana sales. Therefore, reduced transport cost minimizes costs incurred and maximizes gross margins, resulting in higher profitability. This finding is similar to findings elsewhere (Omiti et al. 2009; Natukunda, Kugonza, and Kyarisiima 2011; Ayieko, Bett, and Kabuage 2014; Sigei, Bett, and Kibet 2014) (Table 7).

The number of extension visits positively and significantly ($p < 0.01$) affected profitability of commercial IC production. The higher the number of extension visits per household, the higher the gross margins and hence increased profitability. This is because the more farmers access extension services such as training, the more knowledge they acquire regarding better methods of production. Consequently, these farmers make fewer errors in production and marketing than farmers who do not get extension services (Natukunda, Kugonza, and Kyarisiima 2011; Sigei, Bett, and Kibet 2014). Additionally, extension services, such as vaccinations and treatment of chickens, ensure reduced mortality; hence, higher numbers of chickens are available for sale which increases profitability (Table 7).

Family ownership of IC was found to significantly ($p < 0.01$) and positively affect profitability of commercial IC production. This is because if every household member is entitled to ownership of a certain number of IC, the overall number of IC in the household's pool is likely to be high, resulting in many IC taken to the market for sale; hence, there will be higher gross margins which translate into higher profitability. This finding also resonates with the findings of a study by Lubungu, Chapoto, and Gelson (2012) among smallholder livestock farmers in Zambia. They found that as the size of a livestock herd in a household increases, the proportion taken to market also increases which, in turn, increases the household's gross margins. Gebregziabher (2010) observed a similar effect in market chain analysis in the Tigray region where it was found that flock size positively affected the value of poultry sales. This suggests that households with larger IC flock sizes are more likely to sell more IC, thereby obtaining higher gross margins and hence increasing the profitability of commercial IC production and marketing (Table 7).

The sex of the respondent significantly ($p < 0.1$) and positively influenced profitability of commercial IC production. Men are believed to have strong bargaining power which, in turn, increases the proportion of IC sales and gross margin. The result is consistent with that of Cunningham et al. (2008) who argued that men are likely to sell more and obtain higher gross margins due to their acumen in bargaining, negotiating and enforcing contracts. This argument was also advanced by Dorward, Farrington, and Deshingkar (2004) who concluded that the discriminatory tendencies against women tend to weaken their negotiation prowess and therefore

Table 7: OLS regression of determinants of profitability of indigenous chickens.

	OLS		Robust	
Variables	Coef. (SE)	$P>\|t\|$	Coef. (SE)	$P>\|t\|$
Sex	1.662(0.795)**	0.038	1.662(0.844)*	0.050
Age of household head squared	−0.001(0.000)*	0.061	−0.001(0.000)*	0.094
Bicycle access	4.920(2.780)*	0.079	4.920(1.262)***	0.000
Motorcycle access	1.934(1.404)	0.170	1.934(1.316)	0.143
Access to chicken information	−2.157(1.444)	0.137	−2.156(1.547)	0.165
Group farming involvement	1.673(0.952)*	0.081	1.673(0.873)*	0.057
Number of extension visits	0.300(0.153)*	0.052	0.300(0.086)***	0.001
Ln_Market distance	−0.091(0.467)	0.846	−0.091(0.446)	0.838
Quantity of sunflower sold	0.003(0.003)	0.287	0.003(0.002)	0.128
Family ownership of chickens	2.325(1.015)**	0.023	2.325(0.841)***	0.006
Constant	7.662(1.062)***	0.000	7.662(1.141)***	0.000
F(10, 169)	2.47		4.12	
Prob > F	0.0086		0.0000	
N	180		180	
R^2	0.1277		0.1277	
Adjusted R^2	0.0761			
Root MSE	4.7208		4.7208	

***, ** and * imply coefficients statistically significant at 1%, 5% and 10%, respectively. Figures in parentheses are standard errors.
***Source*:** Survey data (2017)

make them less influential in agro-commodity trade. Although women are mainly involved in production, it is predominantly the role of men to market IC. This is attributed to the fact that men are more market oriented compared to women and hence are able to market more and better, resulting in higher gross margins which, in turn, favours profitability (Martey, Ramatu, and Kuwornu 2012; Sigei, Bett, and Kibet 2014) (Table 7).

The age of the household head significantly ($p<0.1$) and negatively affected profitability of commercial IC production. This implies that younger household heads are more enthusiastic about participating in IC sales and hence obtain higher gross margins than their older counterparts. Barret (2008) stated that younger people participated more in the market than their older counterparts because they are more receptive to new ideas and are less risk averse than the older people. Consequently, they obtain higher gross margins and increased profitability. Additionally, it is also plausible that young farmers do not have as many alternative sources of income as older farmers and, as such, young IC farmers may not have much else to sell (Table 7).

Involvement in a group, especially a farming group, was found to be positively and significantly ($p<0.1$) related to profitability of IC. This could be explained by benefits that accrue through group involvement like lessons learnt from experienced group members about production, collective marketing and how to increase profits. Farming group involvement also results in the creation of social capital among farmers which enables them work together in unity to achieve a common goal. Additionally, these groups are taught basic economic principles such as record-keeping, minimizing expenses and maximizing profits in different enterprises by some non-governmental organizations (NGOs). This is consistent with the findings of Ayieko, Bett, and Kabuage (2014) who found that number of years spent in a group by a farmer increases profitability of IC. Group membership also positively impacts profitability because it increases a household's access to information vital to production and marketing decisions which, in turn, affects profits obtained (Martey, Ramatu, and Kuwornu 2012; Sigei, Bett, and Kibet 2014) (Table 7).

Conclusion and recommendations

Chicks were the most predominant in the flock compared to cockerels, pullets and hens. This is because they are less marketed as they are left to replace sold and growing stock. The overall commercialization level of IC production in Oyam and Omoro districts was found to be low at 31.2%. Of all the flocks, commercialization level of cocks was the highest and above average at 58.1% of total annual production. This is because cocks fetch higher prices compared to other flock composition. This shows the significance of cocks in IC commercialization. Level of egg sales was lowest since most farmers do not sell their IC eggs because they are mainly kept for reproduction. Yet egg sales can be a potential profitable business based on the high price charged per egg (300 UGX per egg). Therefore, the commercialization level (31.2%) reported in this study shows that IC farmers in northern Uganda are yet to become fully commercialized. This is based on the fact this level is below 50% which is the threshold for fully commercialized farmers (World Bank 2008). The study found that major factors affecting level of IC commercialization included IC flock size, number of cattle owned, husband's decision to sell IC, number of school-going children, group involvement and provision of poultry extension services. Since IC flock sizes, number of cattle owned, husband's decision to sell IC and group involvement positively influenced the proportion of IC sold, an increase in their effect on commercialization would result in increased commercialization level. On the other hand, an increase in the number of school-going children and provision of poultry extension services resulted in a decreased commercialization level.

Since commercial IC production in study areas was found to be profitable, measures to increase commercialization would, in turn, increase profits accruing to the enterprise. The study factors that had significant impact on profitability were bicycle access, number of extension visits, family ownership of chickens, sex of respondent, age of household head and group involvement. All these factors except age of household head positively affected profitability of IC. Strategies to ensure ownership of a bicycle by a farmer, and an increase in the number of extension visits and number of chickens kept by each farming family would increase profits accruing to the IC enterprise and hence increase profitability.

This study recommends that since increased flock size increases commercialization level, the government and private sectors have to invest in increasing IC flock sizes through measures such as vaccinations and disease control strategies, as well as promoting innovative assisted-reproductive technologies such as synchronized hatching and artificial brooding of chicks in the first three weeks.

Since group involvement increases commercialization level, government and other policymakers should encourage famers to carry out their production and marketing activities in groups since group involvement enhances learning, increases their bargaining power and enables them enjoy economies of scale. Additionally, community-based officers should continuously provide training on group dynamics and ensure that groups are continuously active.

This study also recommends provision of poultry extension services by agricultural service providers that specifically targets IC enterprises to ensure transformation of subsistence to commercial IC production.

Additionally, a working innovation platform should also be put in place to link all the value chain actors of IC for purposes of networking and finding market for IC along the chain. Having various potential buyers empowered will definitely increase the proportion of IC marketed and thus increase profits.

Similarly, farmers are also advised to sell their IC in competitive places such as urban markets. A case in point is that respondents in Omoro had higher gross margins and this could be associated with their close proximity to Gulu which is a major urban area that offers higher prices for IC.

The key implication of this study is that policy, technological, organizational and institutional interventions aimed at enhancing commercial IC production should focus on increasing proportions of IC marketed and increasing profitability of IC production. Higher profits result in increased incomes and thereby lead to sustainable improvement in the farmers' livelihoods.

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