COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE

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TREND ANALYSIS OF EGG PRODUCTION: IN CASE OF ETHIO-CHICKEN IN THE GUBRE SUBCITY

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CHAPTER ONE

INTRODUCTION

1.1. Background of the study

In Ethiopia, the agricultural sector is a cornerstone of the economic and social life of the people (Tadesse et al., 2005). At national level in Ethiopia, 99% of the total, 56.5% million, estimated chickens are contributed by village poultry production while only 1% is form intensive exotic breed maintained under intensive management system (Taddesse et al., 2005). Livestock production covers 40% of agricultural output in Ethiopia, playing an important role in national economy as it contributes 18% of the total GDP (FAO, 2004). A Central Statistics Agency (CSA) (2005) report revealed that 97.8% of the total poultry population Comprises indigenous birds, while 2.2% are exotic breeds. The poultry sector in Ethiopia can be characterized into three major production systems based on some selected parameter such as breed, flock size, housing , feed, health, technology, and bio-security. These are large commercial, small scale commercial and village or backyard poultry production system. These production systems have their own specific chicken breeds, inputs and production properties. Each can sustainably coexist and contribute to solve the socio-economic problems of different target societies (Tadelle et al., 2003).

The backyard (traditional) poultry production system is characterized by low input, low output and periodic destruction of large proportion of the flock due to disease outbreaks (Tadelle et al., 2003b). With the aim of improving poultry productivity, different breeds of exotic chickens (Rhode Island Red, Australord, New Hampshire and White Leghorns) were imported to Ethiopia since the 1950s. Since then higher learning institutions, research organizations, the Ministry of Agriculture and Non-Governmental Organizations (NGO's) have disseminated many exotic breeds of chickens to rural farmers and urban-based small-scale poultry producers (Solomon, 2008).

The diverse agro ecology and agronomic practice prevailing in the country together with the huge population of livestock in general and poultry in particular, could be a promising attribute to boost up the sector and increase its contribution to the total agricultural output as well as to improve the living standards of the poor livestock keepers.

Poultry production, as one segment of livestock production, has a peculiar privilege to contribute to the sector. This is mainly due to their small size and fast reproduction compared to most other livestock and its well fitness with the concept of small-scale agricultural development. Moreover, it goes eco friendly and does not compete for scarce land resources. Poultry farming is widely practiced in Africa almost every farmstead keeps some poultry mainly for consumption and cash sales. Religions and cultural considerations are also amongst the reasons for keeping chickens by resource poor farmers in Africa. (Dwinger et al., 2003).

Although, Gubre subcity which is found in Gurage Zone, southern Ethiopia has poultry farming practiced in the area, there is no well documented and no research conducted so for in the area in determining the poultry production practices by assessing its potential and constraints. Therefore, this research aimed to assess the existing potential constricts of poultry production in the study area.

1.2. Statement of the problem

Poultry products especially, egg production is an integral part of gubre breeding farming system. Even though the area has potential for egg and poultry products, little is known about the applying poultry production system and techniques, building appropriate model of egg production, and opportunities associated with paltering in the area. The customers of the sector couldn’t get amount of egg they want. Therefore, this study is designed to give directions these problems by applying appropriate method of egg production and give hints for the sector weather the production will decrease or increase in the next year.

1.3. Objective of the study

I General Objective

The general objective of this study will be to fit time series model and forecast of eggs production at Ethio-chicken in the Gubre breeding farm.

II Specific objectives

The specific objectives of this study are the following

- To study the trend of egg production at Ethio-chiken in Gubre subcity.
- To fit and select appropriate model for monthly egg production at Ethio-chiken in Gubre subcity.
- To forecast the egg production pattern at Ethio-chiken in Gubre subcity.

1.4. Significance of the study

The outcome of this study will expect to contribute the methodology of measuring trend of eggs yield and as option as customers requirements. By predicting future amount of egg production we can improve need of our customers and also increase profit from the production.

CHAPTER TWO

LITERATURE REVIEW

2.1. Characterization of smallholder poultry production systems.

Generally, there are four poultry production systems in developing countries and in Africa. These include the free-range system or traditional village system; the backyard or subsistence system; the semi intensive system and the Small-scale intensive system (Bessei, 1987; Sonaiya, 1990a; Kitalyi, 1998; Branckaert and Gueye, 2000 and Gueye, 2000a). The most common production system found in Africa are the free-range and backyard production systems (Sonaiya, 1990a; Gueye, 2003) and approximately 80% of chicken populations in Africa are reared in these systems (Gueye, 1998). The chicken in this system are a function of natural selection. As a result the performance of chickens under rural conditions remain generally poor as evidenced by highly pronounced broodiness, slow growth rates, small body size and low production of meat and eggs (Kitalyi, 1998; Sonaiya, 2000). Poultry production systems in Ethiopia show a clear distinction between traditional low input systems and modern production system using relatively advanced technology. There is also a third emerging small-scale intensive system as an urban and pier urban small-scale commercial system (Alemu and Tadelle, 1997).

2.2. Importance of the small holder chicken production systems

Chicken production is an important agricultural activity of almost all rural communities in Africa, which makes the best use of locally available resource. Though neglected in the development themes for a long time, now a day's many researchers and development agents are becoming in to consensuses that the small holder chicken production play a major role in poverty alleviation and food security at household level. It provides off-farm employment and income generating opportunity and source of gifts and religious sacrifices (Wethli, 1995; Sonya, 1990a; Gueye, 2003; Tadelle and Ogle, 2001; Sonaiya, 2000). Scavenging chicken also serve in waste disposal system by converting left over of grains and human foods and insects in to valuable protein foods-egg and meat (Doviet, 2005).

The smallholder poultry production considered as an income-yielding activity that fits well with the concept of small-scale agricultural development. Moreover, land, which is a critical production resource in rural Ethiopia, is not a limiting factor in the smallholder chicken production systems. Village chicken products are often the only source of animal protein for resource-poor households.

2.3. Socio economic aspects of poultry production

2.3.1 Social and economic scenario.

Nearly all rural families keep a small flock of poultry and rearing of poultry has practiced for many generations for different social and cultural reasons (Gueye, 2003). However, the most common purpose for keeping chickens and eggs were primarily as source of income and for hatching, respectively. According to the study conducted in the Central Highlands of Ethiopia by Tadelle et al. (2003), about 50, 27 and 23% of the egg produced are used for hatching, sale and home consumption, respectively. In another study conducted by Aberra (2007) in southern 10 parts of Ethiopia, about 71.4% of chickens raised by the rural community were used for egg production while the rest 28.6% were used for meat production purposes.

There are fewer religious or social taboos associated with poultry production than there are with pigs and cattle. Poultry keeping rather has a symbolic importance within the context of social cultural and religious function. For most of these social and cultural functions or sacrifices, a specific sex and plumage color of poultry are prescribed (Gueye, 2003). For instance, Tadelle and Ogle (2003) reported white and red cock sacrificed for the purposes of good harvest wishes and red and black spotted cock sacrificed for the purpose of Ethiopian New Year. In general, rural poultry plays a significant role in cultural and social life of rural people in the following ways: as gifts for relatives and for religious ceremonies, cock as alarm clock, to cure a sick person, staring capital to youth and for special guests' invitation. For instance, farmers in rural area invite special guests to partake of the popular dish "doro wat", which contains both chicken meat and eggs and (Sonya, 1990a; Sonaiya, 2000; Tadelle and Ogle, 2001).

2.3.2. Decision making on and ownership of chickens

The pattern of ownership differs to some extent according to sex and age of the owner; hence, the ownership of chickens shared among all gender categories. No data are available at national level. However, some studies showed that women have a more active interest in poultry ownership than men do. According to the survey made in Welaita (Hoyle, 1992), senior men and senior women have the highest flock ownership accounting to 30% and 47%, respectively when compared to the other gender groups boys and girls. Usually ownership affects decision-making and management of the chickens. The management of rural chicken in Africa is a family affair with construction of chicken house and major decisions making issues such as sale of chicken and eggs and consumption of poultry products under the control of the men. Whereas looking after chicken, controlling and utilizing the earnings from the sale of eggs and chicken belongs to women (Gueye, 2003). Kitalyi (1998) showed that in Gambia, there was gender plurality in decision-making in village chickens production. The same source indicated that in the United Republic of Tanzania men dominated in both selling and buying chickens in village markets.

2.4. Egg composition

Eggs mainly consist of shell, albumen (egg white), yolk, chalazae, and anaircell and shell membranes. Egg albums made up of four distinct layers. These are outer thin white, viscousor thick white, inner thin white, and achalaziferous layer (Almquist& Loenz, 1933).It contains about 85% (indrys matter**)** of the total protein content of an egg(Bennion&Bamford,1997). The whites are viscous and high PH (PH 8.2-9) (Toney & Bergquist, 1993) in fresh egg. The PH changes to a maximum value of about 9.7 (Heath, 1977) during storage due to the loss of carbon dioxide. Egg yolk can be regarded as a mixture of particle and plasma. The plasma includes low-density globules which are rich in fat (Parkinson, 1966). The egg yolk protein (livetin) consists of lipoproteins. The PH of egg yolk is Ph6.0 for fresh eggs whereas the pH changes to between pH 6.4 - 6.9 during storage (LI-chanetal., 1995).

2.5. Egg processing

Improved technology and the development of mechanical equipment were responsible for small-scale egg processing lines to become large commercial operations(American Egg Board,2000).egg products for commercial usage include liquid, frozen and dried whole egg, albumen and yolk. Various blends of whole egg and yolk are also included. Steps to be followed during whole egg processing are; breaking, homogenization, pasteurization, freezing and drying.

CHAPTER THREE

DATA AND METHODOLOGY

3.1 Source of data

For this study, the data will be obtained from Ethio-chicken in the gubre subcity poultry farm sector from secondary data.

3.2 Data Analysis in Time Series

Test of stationarity

I) Graphic Inspection (correlogram test)

We can identify stationary by using the graph of the correlogram of the series. The correlogram of stationary series drop off as k, the number of lags becomes large.

II) Augmented Dickey Fuller ADF) Test

By including lags of the order *p* the ADF formulation allows for higher-order autoregressive processes. This means that the lag length *p* has to be determined when applying the test. One possible approach is to test down from high orders and examine the t-values on coefficients. An alternative approach is to examine information criteria such as the Akaike information criterion and Bayesian information criterion.

The testing procedure for the ADF test is applied to the model

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t,$$

Where α is a constant, $\beta$the coefficient on a time trend and p the lag order of the autoregressive process Imposing the constraints $\alpha = 0$ and $\beta = 0$ corresponds to modeling a random walk and using the constraint $\beta = 0$ corresponds to modeling a random walk with a drift. The unit root test is then carried out as:

Ho: $\gamma = 0$ non stationary

Ha: $\gamma < 0$ stationary

Test statistic is given by

$$DF_\tau = \frac{\hat{\gamma}}{SE(\hat{\gamma})}$$

is computed and compared to the critical value for the Dickey–Fuller Test. If the test statistic is less than the critical value, then the null hypothesis of $\gamma = 0$ is rejected and no unit root is presented.

III) The Phillips-Perron (PP) Test

It is used in time series analysis to test the null hypothesis that a time series is integrated of order 1.It builds on the Dickey–Fuller test of the null hypothesis $\delta = 0$ in $\Delta\ y_t = \delta y_{t-1} + u_t$, where Δ is the first difference operator. Like the augmented Dickey–Fuller test, the Phillips–Perron test addresses the issue that the process generating data for y_t might have a higher order of autocorrelation than is admitted in the test equation - making y_{t-1} endogenous and thus invalidating the Dickey–Fuller test zero. The testing procedure for the PP test is applied to the model $yt = \alpha + \rho yt - 1 + \delta t + \mu t$.

The PP test is based on the statistic:

$$\hat{t} = t_\alpha \left(\frac{\gamma_o}{f_o}\right)^{1/2} - \frac{T(f_o - \gamma_o)}{2{f_o}^{1/2}s}(se(\hat{a}))$$

Where â is the estimate of α, tα is the t -ratio of α, se(â) is coefficient standard error and s is the standard error of the test regression. In addition, γo is a consistent estimate of the error variance, The remaining term, f_o , is an estimator of the residual spectrum at frequency zero.

3.3. Examining stationary of time series data

1) **Time series plot:-**
   - If a time series is plotted and if there is no evidence of a change in a mean over time then we say the series is stationary on the mean.
   - If the plotted series shows no obvious change in the variance time then we say the series is constant variance.

2) **ACF (Autocorrelation function)**

The autocorrelation of stationary data drops to zero relatively quickly, while for non-stationary data they are significantly different from zero for several and PACF will have a long spike close to 1 at lag 1.

3) **Transformations**

Transformation: is the process of changing a non stationary time series into a stationary time series. It is often useful to transform time series for analysis or forecasting. Many time series analysis and forecasting methods are most appropriate for time series with an unrestricted range, a linear trend, and a constant variance. Series that do not conform to these assumptions can often be transformed to series for which the methods are appropriate.

3.4. Approaches to Time Series Analysis

3.4.1 Estimation of Trend Component

Least square method: It plays an important role in finding the trend values of economic and business time series. It helps us to forecast future values. It is given by

$Y=a+bx+\varepsilon_t$, where a and b can be obtained by solving two normal equation**.**

3.5. Time series model

I. White Noise (pure random) process

A time series is called white noise if $\{Y_t\}$ is a sequence of independently and identically distributed random variables with finite mean and variance. The means $Y_t= \mu t$ describes a pure random process with:

$E(\varepsilon_t) = 0$

$Var(\varepsilon_t) = \sigma_2$

$E(\varepsilon_t\varepsilon_s) = 0 \ \forall t \neq s$ and in addition εt is normal distributed. This assumption is expressed by writing: $\varepsilon_t \sim$ i.i.d. $N(0, \sigma^2)$

Where i.i.d. stands for independently and identically distributed random variable.

II. Autoregressive process of order p, AR (p):

ACF/PACF Patterns for **AR** models tend to fit smooth time series well, while MA models tend to fit irregular series well. It is given by the following general formula.

$Y_t = \alpha_1 Y_t\text{-}1 + \alpha_2 Y_t\text{-}2 + \ldots + \alpha_p Y_t\text{-}p + \varepsilon_t$.

$\varepsilon_t \sim$ i.i.d. $N(0, \sigma^2)$

The Stationarity or non-stationarity depends on the coefficients α, i = 1... p that is if

Absolute value of alpha lie inside the unit circle, it is stationary.

III Moving Average Model of Order q, MA (q).

It is given by the following formula:

$Y_t = \beta 1 \varepsilon_t\text{-}1 - \beta 2 \varepsilon_t\text{-}2 - \ldots - \beta q \varepsilon_t\text{-}q + \varepsilon_t$

MA (q) can be represents as AR (∞), thus we expect the opposite patterns for MA processes. The PACF will dampen exponentially. The ACF will be used to identify the order of the MA process.

IV Autoregressive Moving Average, ARMA (p, q).

It is given by the following the general equation as follows:

$y_t = \alpha 1 y_t{-}1 + \ldots + \alpha p y_t{-}p + \varepsilon_t + \beta 1 \varepsilon_t{-}1 - \ldots - \beta q \varepsilon_t{-}q$, with ε_t white noise

It is the combination of autoregressive and Moving Average. If p=0,it is reduced to (MA) and if q=0, it reduced to MA(q), process. We may see dampening in both the ACF and PACF, which would indicate some combination of AR and MA processes. Once we have examined the ACF & PACF, we can move to the estimation stage.

V Autoregressive integrated moving average ARIMA (p, d, q).

In practice most time series are non stationary. One procedure that is often used to convert a non stationary series to stationary is using successive difference. Formula of ARIMA

$\nabla y_t = y_t - y_{t-1} = y_t - By_t = (1\text{-B})\, y_t$

$\nabla^d y_t = (1 - B)^d y_t$

Where B is lag operator

Box-Jenkins methodology: The Box-Jenkins methodology refers to a set of procedure for indentifying and estimating time series models with the class of Autoregressive process (AR), Moving Average (MA), ARMA, and ARIMA models.

3.6. Building ARIMA Models

a) Model selection and identification:

Identification and selection applied when the data confirmed stationary only. This step is the determination of the appropriate values of p, d, & q using the ACF, PACF, and unit root tests (p is the AR order, d is the integration order, q is the MA order). If the series is MA (q) process it cutoff the limits after certain lag k and if it is AR (p) and ARMA (p,q) sample auto correlation dies gradually as k increases. Tentative identification of models identified by using sample-Autocorrelation function (ACF), Partial autocorrelation (PACF), Akaike information criterion (AIC) and Bayesian information criterion (BIC) .

Autocorrelation Function (ACF): The ACF represents the degree of persistence over respective lags of a variable.

$$\boldsymbol{\rho_k = \gamma_k / \gamma_0} = \frac{\text{covariance at lag k}}{\text{Variance}}$$

Partial Autocorrelation Function (PACF)

The lag k partial autocorrelation is the partial regression coefficient, θ_{kk} in the k^{th} order auto regression and given by;

$y_t = \theta_{k1}y_{t-1} + \theta_{k2}y_{t-2} + \ldots + \theta_{kk}y_{t-k} + \varepsilon_t$

By using ACF and PACF we can identify model as follow

	AR(p)	MA(q)	ARMA(p,q)
ACF	Tail off	Cut off after lag q	Tail off
PACF	Cut off after lag p	Tail off	Tail off

Table 3.1 model identification using ACF and PACF.

b) Parameter Estimation

It is the step in which estimation of parameters are required. There are three methods to estimate parameters. These are moment method, least square estimate and maximum likelihood estimate. If the model is AR (p) process we can estimate by using Yule walker equation. However, for both AR (p) and MA (q) process it is possible to estimate by sample autocorrelation function. The estimation-stage results will be used to check Parameter estimates, the appropriateness of coefficient estimates which includes the statistical significance of estimated coefficient and standard error and correlation matrix.

c) Diagnostic checking:

After fitting a provisional time series model, we can assess its adequacy in various ways. We check residuals of estimate of ARIMA model(s) to see if they are white noise; Autocorrelation Function (ACF) pick best model with well behaved residuals. Once we have identified a tentative model the next step is to determine the adequacy of the models.

Adequate model:

- The errors are random.
- All parameter estimated are significantly different from zero.
- The model has the smallest root mean squared error

Analyzing the residuals

To determine whether the error are random or not we use the modified Ljung Box Pierce statistic.

I. Test hypothesis

Ho: $\rho_1 = \rho_2 = \ldots\ldots\ldots = \rho_k = 0$ [model is correct]

H1: $\rho_i \neq 0$ for at least one k=1, 2…….k [model is not correct]

II. Level of significance (α)

III. Test statistic; [Modified Box Piece statistic]

$$Q = n(n+2)\sum \frac{r^2{}_k}{n-k} \sim x^2{}_{\alpha\ (k-p-q)}$$

IV. Decision rule: if $Q_{Cal} > x^2{}_{\alpha\ (k-p-q)}$, then the null hypothesis will be rejected, that means the model is not correct. If $Q_{cal} < x^2{}_{\alpha\ (k-p-q)}$ null hypothesis will be fail to reject, that means the model is correct.

d) Forecasting: The last step of the ARIMA modeling process is forecasting. In forecasting, the goal is to predict future values of a time series variable, xt+k, k =1, 2 . . . based on the data collected to the present, x = {xt, xt−1. . . x1}. Throughout this section, we will assume xt is stationary and the model parameters are known.

3.7. Model selection criterion

- **Akaike Information Criterion (AIC)**

Given a set of model for the data, the preferred model is the one with the minimum AIC and BIC value. Hence **AIC** not only rewards goodness of fit, but also includes a penalty that is an increasing function of the number of estimated parameters.

This penalty discourages over fitting (increasing the number of free parameters in the model improves the goodness of the fit, regardless of the number of free parameters in the data-generating process). It is given by

$$AIC = 2k - 2\ln(L)$$

Where k is the number of parameters in the statistical model, and L is the maximized value of the likelihood function for the estimated model. The AIC penalizes the number of parameters less strongly than does the Bayesian information criterion (BIC).

- **BIC (Bayesian Information Criterion)**

The BIC is an asymptotic result derived under the assumptions that the data distribution is in the exponential family.

BIC=-2*ln (L)+kln(n)

n = sample size

k = the number of free parameters to be estimated

L = the maximized value of the likelihood function for the estimated model.