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Technical Efficiency-Food Security Nexus in Kaduna State, Nigeria: A Case Study of Poultry Egg Farmers

Oyinbo Oyakhilomen
Department of Agricultural Economics and Rural Sociology,
Ahmadu Bello University, Nigeria
ooyinbo@abu.edu.ng
+2348032779442

Adah Itodo Daniel
Department of Agricultural Economics and Rural Sociology,
Ahmadu Bello University, Nigeria

Rekwot Grace Zibah
National Animal Production Research Institute
Ahmadu Bello University, Nigeria

Abstract

This study analysed the technical efficiency of poultry egg production for sustainable food security in the study area using primary data. The data were analysed using stochastic frontier, the US Department of Agriculture (USDA) food security measurement, and correlation analysis to determine the relationship between technical efficiency and food security. The result of the study revealed that the poultry egg farmers had a very low technical efficiency of 23%, which implies that the poultry egg farmers have a chance of improving their technical efficiency by 77% using their available resource efficiently. The result also revealed that few of the households (10%) were food secure while most of them (90%) were food insecure at different levels of food insecurity. The result of the study further indicated a direct relationship between technical efficiency and food security at 1% level of probability, implying that as average productivity increases, food security increases. The policy implication is that food security among the poultry egg farmers is linked with improving their farm efficiency. If food security is to be ensured among the poultry egg farmers, their farming activities must be efficient. The study recommended that the poor food security status of the poultry egg farmers be improved by addressing their low level of technical efficiency through ensuring the efficient utilization of their available resources. This calls for emphasis on extension activities to focus on training poultry egg farmers on improved production management practices.

Author's Note

This study was borne out of the need to address the issue of food security among poultry egg farmers in the study area in a bid to ensure sustainable development. However, the pertinent question of interest which formed the basis for this study was whether the efficiency of production of the farmers has a significant link with their food security and what policy implication can be drawn from the outcome of such a link.

Keywords: Egg, food security, poultry, technical efficiency.

1. Introduction

Although the Nigerian economy depends significantly on the oil sector, agriculture remains its mainstay. Agriculture contributed 42% of Nigeria's Gross Domestic Product (GDP) in 2008 (National Bureau of Statistics, 2010). Agriculture is the second-largest export earner after crude oil and employing over 70% of rural labour; thus, the sector ranks as a key contributor to wealth creation and poverty reduction (Nwafor, 2008). Nigeria's agricultural sector comprises four sub-sectors: Crops, Livestock, Fisheries and Forestry. Crops contribute about 85% to agricultural GDP, livestock production about 10%, fisheries about 4%, and forestry about 1% in 2006. The crops and livestock sub-sectors have maintained their shares in recent years, while the fishery has been expanding and the forestry shrinking (Nigeria vision 2020, 2009). Given the large size of the crops sub-sector relative to the other three, growth performance in the crops sub-sector drives overall growth performance in agriculture. However, growth in the sector has not kept pace with the needs and expectations of the nation. Over the years, the contributions of the livestock sub-sector to Gross Domestic Product (GDP) have decreased from 5.61% in 1960 to about 2.64% in 2010 (CBN, 2010). Food production increases have not kept pace with population growth (except in recent times), resulting in rising food imports and declining levels of national food self-sufficiency.

Poultry production is one of the important components of the livestock subsector in the Nigerian economy, which can be embarked upon by the people with small or no land capital (Conroy, 2005). Nigeria's poultry industry is composed of local unimproved breeds and high performing commercial breeds. Over the last 50 years, the exotic breed has made an aggressive incursion into the productive economy of the country. While the local chicken is driven by the traditional system of management, the exotic breeds have stimulated an industrial advancement of the poultry industry through specialization as egg- or meat-type strains to satisfy the increasing demand for poultry commodity in the food market. Poultry meat and eggs offer considerable potential for meeting human needs for dietary animal supply (Folorunsho and Onibi, 2005). This single reason, among others, has made the enterprise attractive and popular among small-, medium-, as well as large-scale poultry farmers.

Efficiency is an important factor of productivity growth, especially in developing agriculture where resources are meagre and opportunities for developing and adopting better technologies are dwindling (Ali and Chaudhry, 1990). Such economies can benefit greatly by determining the extent to which it is possible to raise productivity or increase efficiency, at the existing resource base or technology. The analysis of technical efficiency is generally associated with the possibility of farms producing a certain optimal level of output from a given level of resources, or certain level of output at least cost. Technical efficiency of poultry egg farmers varies due to the presence of technical inefficiency effects in poultry production in Nigeria (Adepoju, 2008). The presence of shortfalls in productivity means that output can be increased without requiring additional conventional inputs and without the need for new technology. If this is the case, then empirical measures of technical efficiency are necessary in order to determine the magnitude of the gains that could be obtained by improving performance in poultry production with a given set of inputs.

Challenges of food insecurity and hunger worldwide and in developing countries like Nigeria in particular have continued to receive attention from experts and governments. (Emaikwu *et al.*, 2011). Food security is a dynamic idea that has undergone significant transformations in its conceptual lifetime. Perhaps the most significant of these transformations is the shift from an initial view of food security as a product of reliable supplies of food to the growing contemporary emphasis on food, such as egg production as a single input in diffuse local livelihood strategies (Edward, 2006).

The production of eggs has been troubled by unstable trends in the economy. The several problems plaguing the industry make it difficult for existing firms to expand while new ones are reluctant to go into the business. Such problems include high cost of feed, low capital base, inefficient management, technical or production inefficiency, diseases and pests, poor housing, poor quality of day-old chicks, inadequate extension and training facilities, and other marketing problems (Ohajianya *et al.*, 2013). This situation has forced many small-scale poultry farms to close down, and those still managing to survive are producing at very high cost and also contending with serious inputs limitations. In most situation, measures adopted by both the government and farmers to improve the situation are geared towards reimbursing the input supplies, which are mainly targeted to production increase neglecting the productivity aspect of the enterprise. However, in line with Onyenweaku and Effiong (2006) and Ashagidigbi *et al.* (2011), one of the major problems of poultry production in Nigeria is that of low productivity and inefficiency in resource allocation and utilization. Improvement of efficiency can be as one of the most effective methods to realize production development. From the available literature, studies have been carried out on technical efficiency of poultry farmers in different parts of Nigeria. Such studies were under taken by Alabi and Aruna (2006), Binuomote *et al.* (2008), Ohajianya *et al.* (2013), Ojo (2003) and Adepoju (2008). However, there is limited information on relationship between technical efficiency and food security of poultry egg farmers, and this constitute the gap in research that formed the basis for this study. In view of the foregoing, this study was carried out to

i. determine the technical efficiency of poultry egg farmers in the study area;
ii. estimate the determinants of technical efficiency of poultry egg production in the study area;
iii. estimate the food security status of poultry egg farmers in the study area;
iv. determine the relationship between technical efficiency and food security of poultry egg farmers in the study area;

2. Methodology

2.1 Description of the Study Area

The study was carried out in Sabon-gari Local Government Area of Kaduna state of Nigeria. Sabon-gari is located in the Northern Guinea Savannah Zone of Kaduna state. The Local Government Area is situated on a plateau of a height of about 700m above sea level at latitude 11° to 12° north and longitude 7° to 8° east. It

has an estimated population of 291,358 (National Population Commission, 2006). With a projected population of 932,346 in 2013 using an annual growth rate of 3.2%.

2.2 Sampling Procedure and Sample Size

A two-stage sampling technique was used in the study. First stage involved the purposive sampling of four (4) wards out of eleven (11) wards in Sabon-gari Local Government Area. The selected wards were; Samaru, Bassawa, Jama'a, and Hanwa ward. These wards were selected because of their prominence in poultry egg production. The second stage involved the sampling of thirty (30) poultry egg farmers from Samaru ward and all poultry egg farmers from Bassawa (10), Jama'a (5) and Hanwa wards (6), to give a sample size of fifty-one (51) poultry egg farmers in Sabon-gari Local Government Area. The use of purposive sampling of thirty poultry egg farmers from Samaru is on the basis of the fact that there is high number of poultry egg farmers in Samara ward, especially within the University community.

2.3 Method of Data Collection

The study made use of primary data. The primary data were collected through the use of a well-structured questionnaire. Data were collected on the socio-economic characteristics of respondents (such as age, educational level, household size, income, access to credit, farming experience, gender, marital status, extension contact, membership of cooperative, and so on). Data on the inputs and outputs of poultry farming such as flock size, labour, feeds, medication, fuel, drinkers, feeders, egg, spent/culled layers and poultry manure were also collected. Finally, data were collected on the food consumption of the farmers to estimate their food security.

2.4 Analytical Techniques

Analysis of data collected from the field was done using the following analytical tools; stochastic frontier production function, the United States Department of Agriculture (USDA) food security approach, and Pearson correlation analysis.

2.4.1 Stochastic Production Frontier Function

This analytical tool was used to achieve objective (i) and (ii) of the study. The stochastic production frontier function is specified as

$$Y = f(X_i, a) \exp(e_i) \quad \ldots\ldots (1)$$

Where,

Y = egg output in ith farm (measured in physical terms as number of creates of eggs).
X_i = vector of inputs used by the ith farmer.
•i = vector of unknown parameters.
$e_i = V_i - U_i$ (composite error term).

The specified Cobb-Douglas production functions is as follows:

$$InY = In\square_0 + \square_1 InX_1 + \square_2 InX_2 + \square_3 InX_3 + \square_4 InX_4 + e_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(2)$$

Where,

Y = eggs (number of egg crates)
X_1 = labour (man-days)
X_2 = feed (kg)
X_3 = stock of size (number of birds stocked)
X_4 = water (litres)
In = natural logarithm
a_1 - a_4 = parameters to be estimated.

Where,

a_0 = intercept
e = composite error term defined as V -U in equation (1)

Some farmers' characteristics were incorporated into the frontier function, as it is believed that they have direct influence on efficiency. The efficiency function in specified as

$$R = \square_0 + \square_1 Z_1 + \square_2 Z_2 + \square_3 Z_3 + \square_4 Z_4 + \square_5 Z_5 + \square_6 Z_6 + {}_7\square Z_7 + e \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where,

R = technical inefficiency
Z_1 = age (years)
Z_2 = poultry farming experience (years of poultry farming experience)
Z_3 = educational status (years of formal education)
Z_4 = household size (number of members of a given household)
Z_5 = membership of association (years of membership of association)
Z_6 = access to credit (amount of credit obtained)
Z_7 = extension contact (number of extension contacts)

2.4.2 USDA Food Security Approach

The USDA food security approach adopted from Fakoyode *et al.* (2009) was used to achieve objective (iii) of the study. The USDA method categorizes households using a constructed food security scale (USDA, 2000). This scale is a number continuum in a linear scale that ranges between 0 and 10. The scale measures the degree of food insecurity/hunger experienced by a household in terms of a single numerical value. The procedure that determines a household scale fundamentally depends on the household responses to some structured survey questions. In determining the household food security status on the food security

scale, the food security scale is first simplified into a small set of categories as in Table 1. Four categories can be defined for this purpose. These include:

Food secure households: These are households that show zero or minimal evidence of food insecurity. The group's value ranges between 0-2.32 on the food security scale.

Food insecure without hunger households: This group of households shows concern about the adequacy of the household food supply. They therefore show adjustments in their daily food management. This group's value ranges from 2.33-4.56 on the food security scale.

Food insecure with hunger (moderate) households: This group of households have their food intake reduced such that the household adults have repeatedly experienced the physical sensation of hunger. The group's value is between 4.57-6.53 on the scale.

Food insecure with hunger (severe) household: Households in this group have their children's food intake reduced to an extent that the children have experienced hunger. The group's value on the food security scale ranges between 6.54-10.0.

Table 1: Household food security status

<table>
<tr><th>0-2.32</th><th>2.33-4.56</th><th>4.57-6.53</th><th>6.54-10.0</th></tr>
<tr><td rowspan="3">Food security</td><td colspan="3">Food insecurity</td></tr>
<tr><td rowspan="2">Food insecure without hunger</td><td colspan="2">food insecure with hunger</td></tr>
<tr><td>“moderate”</td><td>“severe”</td></tr>
</table>

2.4.3 Pearson's Correlation Analysis

This was used to achieve objective (iv) of the study. Correlation is the relationship between two variables. Correlation coefficient is the measurement of correlation. It indicates how well the two set of data are interconnected. It is also referred to as Pearson product moment correlation coefficient. The values of Pearson's correlation coefficient lies between -1 to +1. If the coefficient of correlation is 0, then there is no correlation between given two variables. On the other hand, the perfectly positive correlation has a value of +1 while a perfectly negative correlation has a value of -1. Pearson's correlation coefficient is denoted as "r" and is obtained as follows:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{[n\sum x^2 - (\sum x^2)][n\sum y^2 - (\sum y)^2]} \quad (4)$$

Where,

r = Pearson's correlation coefficient
x = values in first set of data
y = values in second set of data
n = total number of values
∑ = summation

3. Results and Discussion

3.1 Technical Efficiency of Poultry Egg Farmers

3.1.1 Input-Output Relationship in Poultry Egg Production

Cobb-Douglas stochastic frontier production function is estimated to examine the nature of the input-output relationship in poultry egg production and to determine the technical efficiency of the farmers. The result presented in Table 2 revealed that the estimated coefficients for all input are positive except stock, which was negative.

In the result presented in Table 2, the coefficient of labour was found positive and significant at 5% level for probability. The positive sign implies that an increase in labour estimate by one unit will lead to an increase in poultry egg output. The result clearly shows that labour is relevant in poultry egg production. This agrees with several other studies such as Muhammed-lawal *et al.* (2009) and Amaza and Maurice (2005), who reported that the coefficient of labour was positive and statistically significant, and that an increase in labour usage would result in increase in output level of farmers. A unit increase in labour will increase output by 0.775 for the poultry egg farmers.

The coefficient of feed was observed to be positive and significant at 5% level of probability. This implies that an increase in the quantity of feed given to the poultry birds (layers) will lead to an increase in output of poultry egg farmers in the study area. The estimated coefficient for stock was found to be negative and insignificant. The negative sign implies that an increase in the stock will lead to a decrease in output. The negative sign was against *a priori* expectation because an increase in stock was expected to increase output given that feed was positive and significant. The coefficient of water was found to be positive and insignificant. The positive sign implies that an increase in the quantity of water given to the birds (layers) will result in an increase in output of egg produced.

Table 2: Maximum likelihood estimates of the stochastic frontier production function for poultry egg farmers

Variables	Coefficient	S.E.	T ratio
Production Model			
Constant	0.861	1.138	0.756
Labour	0.775**	0.322	2.406
Feed	0.727**	0.296	2.459
Stock	-0.222	0.216	-1.027
Water	0.162	0.248	0.654
Inefficiency Model	0.217	1.004	0.216
Age	-0.172*	0.102	-1.685
Farm Experience	2.603	2.322	1.121
Education	0.036	0.494	0.737
Household Size	0.379	0.281	1.345
Association	-0.866**	0.367	-2.358
Access to Credit	-0.000	-0.000	-1.289
Extension Contact	-3.432*	1.953	-1.757
Variance			
Sigma Squared	32.270***	1.013	31.852
Gamma	0.939***	0.028	32.995
Log Likelihood Function	-125.201		
LR test	25.143		

*** = significant at 1% ** = significant at 5% * = significant at 10%

3.2 Determinants of Technical Efficiency of Poultry Egg Production

Maximum likelihood estimate of the Cobb-Douglas stochastic frontier production function was carried out to determine the technical efficiencies as well as the determinants of the inefficiencies of the poultry egg farmers in the study area. Sigma square (σ^2) and gamma (γ) were estimated to be 32.28 and 0.94, respectively, and are significant at 1% level. The sigma square (σ^2) show the goodness of fit of the model while the gamma (γ) shows the proportion of total deviation from frontier attribute to inefficiency of the poultry egg farmers. 0.94 was observed in this study to indicate the presence of inefficiency in poultry egg production among the farmers. This shows that about 94% of shortfall below the frontier output was due to the technical efficiency of the farmers.

The results presented in Table 2 reveal that age was negative and show a significant relationship with technical efficiency among poultry egg farmers in the study area. This result agrees with the finding of Ajibefun and Abdulkadir (2004) on the impact of farm size operation on resource-use efficiency in small-scale farming in south-western Nigeria who said the age of farmers had an increased relationship with farm productivity.

Farming experience is positively related to technical efficiency, thereby decreasing technical efficiency, but is not significant. The more experienced a farmer, the more efficient his decision-making processes, and the more he will be willing to take risks associated with the practice of improved technologies. However, this result

differs from that of Onu *et al.* (2000), whose result showed a negative relationship between farming experience and technical efficiency in cotton production in Nigeria.

Level of education is positive and insignificant in influencing the technical efficiency of the respondents. Education enhances farmers' ability to derive, decode, and evaluate useful information, as well as improving labour quality.

Household size was positive and insignificant in influencing technical efficiency of the poultry egg farmers in the study area. A unit increase in household size will decrease technical efficiency by 0.379. Suggesting that increase in household size of poultry egg farmers decreases technical efficiency. This finding is in agreement with Okoruwa and Ogundele (2006) on technical efficiency differentials in rice production technologies in Nigeria. They reported that household size has no significant effect on the technical efficiency of technology of farming.

Association was negative and significant at 5% level of probability. This implies that membership association increases technical efficiency. A unit increase in membership association will increase technical efficiency by a factor of 0.866. However, this result differs from that of Ohajianya *et al.* (2013), who said that membership in farmers association/cooperative is positively and significantly related to technical efficiency. Members of farmers associations have more access to agricultural information, credit and other production inputs, as well as more enhanced ability to adopt innovations.

Access to credit was negative and insignificant in influencing the technical efficiency of the poultry egg farmers in the study area. The negative sign implies an increase in technical efficiency. This result is consistent with that of Okike (2000), who found a negative relationship between credit and technical efficiency in Northern Nigeria. This result, however, differs from that of Ohajianya *et al*, (2013), who found out that credit access is significant and positively related to technical efficiency. Credit is needed to improve the production of table eggs, and hence the positive relationship between credit access and technical efficiency.

Extension contact was negative and significant at 10% level of probability. The negative sign implies an increase in technical efficiency. As the extension contact of the poultry egg farmers increases, technical efficiency also increases in accordance with *a priori* expectation that extension contact leads to more efficient transmission of information to farmers, as well as enhancing the adoption of innovations.

3.2.1 Distribution of Technical Efficiency of Poultry Egg Farmers

The distribution of poultry egg farmers technical efficiency presented in Table 3 shows that the majority (35.3%) of the respondents were operating at a technical efficiency of 0.0-1.0, with a mean technical efficiency level of 0.23%. This implies that the poultry egg farmers are operating at very low technical efficiency and could increase output if the efficiency of inputs usage were increased by 77% for operating on the production frontier. Consequently, great opportunities still exist for increasing productivity through increased efficiency through the use of available inputs. This result differ from that of Ohajianya *et al.* (2013), whose results showed individual technical efficiency indices range between 16.23% and 94.17% with a mean technical efficiency of 62%.

Table 3: Distribution of Technical Efficiency of Poultry Egg Farmers

Efficiency Score	Frequency	Percentage (%)
0.00-0.10	18	35.3
0.11-0.20	7	13.7
0.21-0.30	10	19.6
0.31-0.40	6	11.8
0.41-0.50	5	9.8
0.51-0.60	3	5.9
0.61-0.70	2	3.9
Total	**51**	100
Maximum	**0.69**	
Minimum	**0.00**	
Mean	**2.23**	

3.3 Food Security Status of Poultry Egg Farming Households

Based on the food security analysis results, presented in Table 4, few of the households (10%) were food secure, meaning that these groups of households are able to meet their food requirement without making any extensive adjustment. Sixty one per cent (61%) of the respondents were food insecure without hunger, and this implies that this group of households has to make extensive adjustment to meet the food needs of their households. Fifteen per cent (15%) of the respondents were food insecure with hunger (moderate), and this implies that this group of households has its food intake reduced such that the household adults have repeatedly experienced the physical sensation of hunger. While 14% of the respondents were food insecure with hunger (severe) as shown in Figure 1, implying that households in this group have their children's food intake reduced to the extent that the children have experienced hunger. These results compares favourably with those of Fakayode *et al.* (2009), which indicated that only 12.2% of the country's households were food secure, while 87.8% of Nigerian households were food insecure at different level of food insecurity.

Table 4: Food Security Status of Poultry Egg Farming Households

Food Security Status	Frequency	Percentage
Food Security FS	5	10
Food Insecure Without Hunger FISWH	31	61
Food Insecure with Hunger (Moderate) FISWHM	7	15
Food Insecure with Hunger (Severe) FISWHS	7	14
Total	51	100

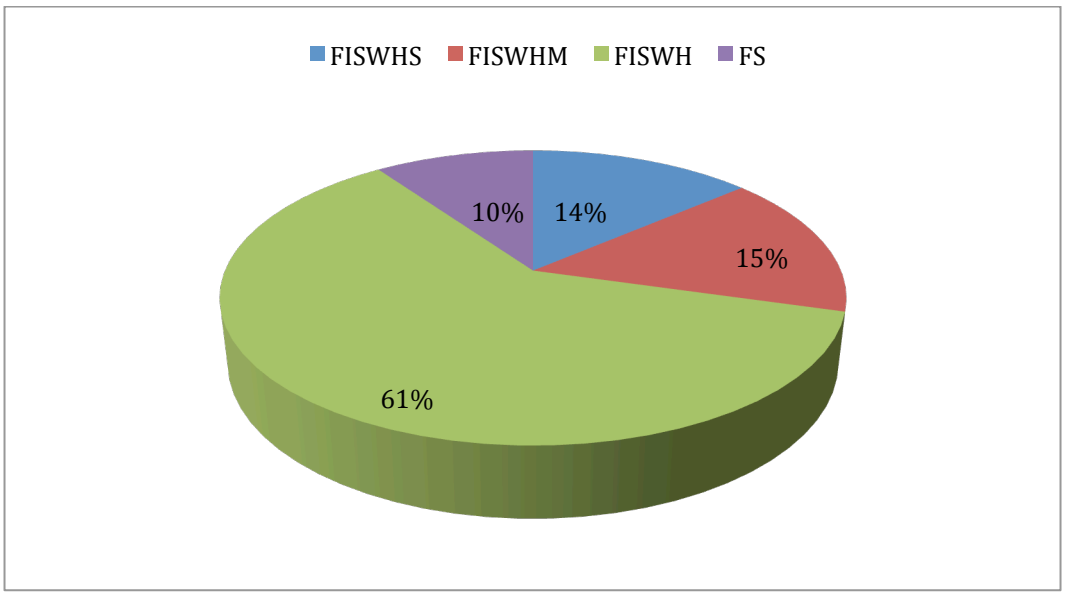

Figure 1: Food Security Status of Poultry Egg Farming Household

3.4 Relationship of Technical Efficiency and Food Security Among Poultry Egg Farming Households

The results in Table 5 show that there is a positive relationship between food security and technical efficiency estimates among the respondents at a 1% probability level, suggesting a direct relationship between technical efficiency and food security estimates among the respondents. This result is in line with that of Asogwa *et al.* (2012), who found a significant negative correlation between poverty gap and technical efficiency estimates among farming households in Nigeria, suggesting an inverse relationship between poverty gap and technical efficiency estimates. The implication of the finding of this study is that as the technical efficiency estimate increases (that is, increase from zero towards one, which is the production frontier), food security increases (that is, accessibility of the households to nutritious food that meet their daily nutrient requirement is increasing). This implies that as average productivity increases, food security increases, suggesting that output is being maximized from a given quantum of inputs. The policy implication is that food security among the poultry egg farmer's is linked with improving technical efficiency. If food security is to be ensured, among the poultry egg farming households, poultry farming activities must be technically efficient.

Table 5: Correlation Analysis of Technical Efficiency and Food Security Among Poultry Egg Farming Households

	Food Security	Technical Efficiency
Food Security	1.00	0.9*
Technical Efficiency	0.9*	1.00

*: Correlation coefficient (r) is significant at 1% probability level

3. Conclusion

Based on the findings of this study, it can be concluded that poultry egg farmers are technically inefficient as indicated by their mean efficiency of 23%; implying that their technical efficiency can be improved by a scope of 77% through efficient resource utilization. There is a direct relationship between technical efficiency and the food security of the poultry farmers in the study area. This implies that the low food security status of the poultry egg farmers in the study area can be enhanced if their technical efficiency is improved upon. Based on the findings of the study, it is recommended that:

i. The poor food security status of the poultry egg farmers be improved by addressing the low level of technical efficiency of the poultry egg farmers, which can be achieved through efficient utilization of their available resources.
ii. Extension activities focus on the training of poultry egg farmers on improved production management practices to enable them to use their available resources efficiently and increase productivity such that their food security is enhanced.

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