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Technical Efficiency Differentials among Poultry Farming Households in Osun State, Nigeria: Implication for Food Security

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Abstract

This research analyzes the link between technical efficiency and food security defined by experience-based household food insecurity and dietary diversity of poultry egg farmers in Osun State, Nigeria. A well-structured questionnaire was used to collect cross-sectional data from 180 participants who were selected through multistage sampling procedure. Data Envelope Analysis (DEA), Household Food Insecurity Access Scale (HFIAS), Household Dietary Diversity Score (HDDS), and probit regression model were the statistical methods utilized. Based on the results, most poultry egg farmers are 44 years old, male, have nine years of farming experience, and possess an average flock of 459 birds. Also, respondents were found that, on average, technical efficiency was 0.73 and 31 per cent of households were food secure. Further, it was noted that diet diversity increased with greater technical efficiency and fruits were the least consumed food, while roots and tubers were the most commonly consumed food. Findings from the probit regression analysis indicate that a greater likelihood of food security is associated with: years of farming experience, technical efficiency, access to agricultural extension services, and credit received, while large family size was a barrier to food security. The study recommends that boosting poultry farmers' technical efficiency by increasing access to productive resources such as credit and training and intensification of advocacy of family planning use to curb the influence of having a big family size will strongly contribute towards ameliorating food insecurity among poultry egg farmers.

Keywords: technical efficiency, household dietary diversity, poultry, food security, Nigeria

Introduction": Villacis, Mayorga & Mishra (2022) opined that Nigeria's agriculture sector contributed 22.35% to the GDP of the country in 2021, with the poultry industry accounting for 25% of this total (Makasi, Lee, Duns, Toromade & Ayo, 2020). Notwithstanding this significant contribution, a number of socioeconomic and environmental problems have created significant barriers to the sector's production and efficiency. Climate change, violence, kidnapping, banditry, the elimination of fuel subsidies, the floating of the currency rate, and the devaluation of the naira are some of these issues. These elements have consequently had a detrimental impact on agricultural output, posing a severe risk to the country's food security (Villacis *et al*., 2022). Food insecurity is a worldwide crisis. Food insecurity was forecasted in 2016 at 1801.9million people, 1929.6 million people in 2017, and 13.8 million people in 2019 (FAO, 2019). In sub-Saharan Africa, there are more than 11.4 million undernourished people, and 798.8 million people, and 724.4 million people are experiencing food insecurity (FAO, 2021). Nigeria is one such state in SSA. Moreover, at least two-thirds of the population was affected by moderate to severe food insecurity in 2022 (FAO, IFAD, UNICEF, WFP, and WHO, 2023). FAO (2021) stated that there were already 12.1 million food insecure Nigerians, since the act of the government and humanitarian organization could be slow, the numbers are predicted to rise to 16.9 million without prompt governmental and humanitarian action.

Nevertheless, food insecurity continues to rise in Nigeria, and in other Sub-Saharan African countries. The Food and Agriculture Organisation (FAO, 2024) indicates that the food security condition of Nigeria deteriorated from 2023 to 2024 due to the rise in the number of food-insecure people, projected to hit at least 33.1 million people between June and August 2025. More recent information from the Nigerian Economic Summit Group (NESG, 2024) confirms the worrying trajectory of the food insecurity levels, with a marked increase in the number of food-insecure Nigerians by 33.8 million people, from 66.2 million in Q1 2023 to 100 million in Q1 2024. Furthermore, the March 2024 report indicates that in the latest figures, 18.6 million people in stress are undergoing acute hunger, while 43.7 million people (also in stress) are coping at crisis levels (or above).

Numerous studies have focused on the link between technical efficiency and food security, with mixed results. For instance, Villacis et al. (2022) evaluated the relationship between agricultural productivity, agriculture and food security as measured by the experience-based measure of food insecurity and found an interesting positive correlation; The World Bank (2014) said that rising agricultural output usually results in improved food security results; studies by Ogundari (2015), Koirala, Mishra and Mohanty (2016), Adeniyi and Dinabobo (2020), Mujemdar, Bala, Arshad, Haque and Hossain (2016), Oyakhilomen, Daniel and Zibah (2015), Oyetunde-Useman and Olagunju (2019), and Ajayi and Olutumise (2018) noted substantial favorable effects of technological efficiency on food security. Adewumi and Animashaun (2014) elaborated on this concept by warning that even while technological efficiency might rise, it does not always equal greater income or a more varied choice of food. They postulated that insufficient market access and families' consumption preferences might explain this. Considering this, it is absolutely necessary to investigate more carefully the correlation between technological efficiency and the Dietary Diversity Index in Nigerian homes that raise chicken eggs—an area still mostly unexamined in the research at present.

Dietary diversity is the range of food categories taken in during a specific time frame and acts as a measure of food security, according to Hoddinott and Yisehac (2002). It reflects the "food access" component of food security, which is a household's capacity to obtain enough food of an appropriate quality and quantity to meet everyone's nutritional needs (Swindale and Bilinsky, 2006). Guaranteeing that the body takes in all the necessary nutrients depends on a varied diet. It enhances digestion, avoids nutritional deficiencies, accelerates growth and development, strengthens the immune system, and lowers the chance of chronic illnesses. Conversely, there is a strong link between restricted food diversity and food insecurity. Recent studies by Ali, Raihan, Siddiqua, Haque, Farzana, and Ahmed (2022) and Antwi, Quaidoo, Ohemeng and Bannerman (2022) have validated this link. Particularly in households that generate poultry eggs, the connection between technological efficiency and food security—as assessed by household dietary variety and the household food insecurity experience scale—has not been investigated. Among chicken egg-producing households in Osun state, Nigeria, therefore this study investigated the association between technical efficiency and food security as measured by household dietary variety and household food insecurity experience scale.

Material and Methods: The study was conducted in Osun State, Southwest Nigeria. Osun State has thirty (30) Local Government Areas. In 1991, the State was sculpted from the former Oyo State. With an estimated population of 4705,600 people (National Population Commission of Nigeria, 2016), the State lies between 7°30′ 0″ N and 4°30′ 0″ E. Ojo, Kassem, Ismail, and Adebayo (2024) estimate average rainfall in the tropical forest belt to range from 1125 mm in the derived savannah to 1475 mm in the derived savannah; average annual temperature fluctuates from 27.2°C in June to 39°C in December. To the north-east Kwara State borders it; Ekiti and Ondo to the east; Ogun to the south; Oyo to the west and northwest. Thanks to its perfect climate and vegetation, agriculture dominates the main living for the people of the state. The farming methods in the state cover both crop and cattle production, including arable and tree crops, as well as poultry, cattle, sheep, goats, and timber production. Additionally, some locals work as civil servants or as craftspeople.

Sampling procedure: For this research, primary data were gathered through a standardised questionnaire; residences in the study region that raised chicken eggs were personally interviewed. A multistage sampling method was applied to select research subjects. The first phase was a straightforward random selection of twelve Local Government Areas (LGAs). For the next phase, three villages were chosen at random from each of the picked local government areas. Six farmers from each of the chosen communities were found in the third step through snowball sampling. Eighteen farming households altogether made up the study area's sample.

Procedures for data analysis: Among the analytical methods utilized in the study to evaluate the collected data were the Household Food Insecurity Access Scale (HFIAS), the Dietary Diversity Score (DDS), data envelope analysis, descriptive statistics (frequency, percentage, and mean), and a probit regression model.

Access Score for Household Food Insecurity (HFIAS): The study assessed access-related elements of food insecurity at the household level using the commonly used and standardised Household Food Insecurity Access Scale (HFIAS) (Ukonu, Wallace and Lowe, 2023; Ojo, Olowoyeye and Ezekiel, 2025). Each of the nine well-crafted questions on the tool represents an increasingly more serious degree of food insecurity. Beginning with questions about uncertainty or worry regarding food accessibility, the series moves to more severe indications like constraints on variety and quality of food and finally ends with questions about decreases in meal size, frequency, and hunger. From mild to severe, this development enables homes to be classified along a food insecurity continuum. Every question in the HFIAS has two sections: first, respondents are asked if a certain experience connected with food insecurity occurred within the last 30 days; if they respond "Yes," they are instructed to evaluate the frequency of this event using standardised options: Rarely (1–2 times), Occasionally (3–10 times), or Frequently (more than 10 times). Each response receives a numeric classification: Never = 0; infrequently = 1; occasionally = 2; often = 3. With nine questions altogether, the total HFIAS score can range from 0 to 27; higher values denote a greater degree of household food insecurity. Based on their responses and scores, households can be grouped into one of four levels of food insecurity: Food Secure, Mildly Food Insecure, Moderately Food Insecure, and Severely Food Insecure. See Coates, Swindale, and Bilinsky, (2007).

Score for Dietary Diversity (DDS): Based on Ukonu et al., (2023), the study employed a well-known metric in nutritional assessment, the Dietary Diversity Score (DDS) created to assess the range of foods eaten by individuals or households over a specified reference period, usually 24 hours. Participants had to list every beverage and food they ate the day before the interview. To calculate the DDS, all reported items were categorised using a standard set of 12 food groups. Typically included in this category of food (Swindale and Bilinsky, 2006) are cereals, roots and tubers, fruits, vegetables, meat, eggs, fish, legumes, milk and dairy goods, oils, sugar, and other goods. One point was given for every food group ingested during the recall period regardless of quantity; hence, tallying the total number of food groups consumed by household members resulted in a figure ranging from 0–12. Dividing the overall DDS by the count of households sampled yields the average DDS.

Data Envelope Analysis (DEA): Based on Hakim, Haryanto and Sari, 2023, Data Envelopment Analysis (DEA) is a technique of maximising a mathematical program calculating the technical efficiency of a Decision Making Unit (DMU) and comparing it with other DMU using similar input and output. DEA formulates DMU as a fractional linear program to determine a solution if the model is changed to a linear program with the weights of input and output. The ratio of total weighted output divided by total weighted output (total weighted output) defines relative efficiency of DMU in DEA as well. This study utilized DEA to estimate poultry egg output in the study region. The DEA model is divided into two parts: Constant Return to Scale (CRS) and Variable Return to Scale (VRS). There are two orientations commonly used in the efficiency measurement method using DEA, input-oriented and output-oriented. DEA assumes that each DMU will have a weight that maximises its efficiency ratio (maximising total weighted output/total weighted input). A DMU is considered relatively efficient if the dual value is equal to 1 (100 percent efficiency). If the dual value is less than 1, the DMU is considered relatively inefficient.

The Output-Oriented Data Envelopment Analysis (DEA) approach is used to analyse the efficiency of poultry egg production under the premise of variable return to scale (VRS).

$\text{Max}_{\theta i} \lambda_i \theta_i$
$s.t. \theta_i y_i - Y\lambda_i \leq 0$
$X\lambda_i - X_i \leq 0$
j'λ = 1
$\lambda_i \geq 0$

The variable output is poultry eggs (IDR). Labour, water, drugs, immunizations, cages, and feed are among other things found in these inputs.

Model of Probit Regression: Because the dependent variable was dichotomous, the probit model was applied in this study. While allowing for the likelihood that independent factors vary throughout the range of 0 to 1, Nagler (2002) notes the probit model guarantees that predicted probabilities are inside that range. More believable distribution of error terms and more realistic probabilities are two more advantages of the probit model (Nagler, 1994). This model holds that while we only see outcomes of 0 and 1 for variable F, there is a latent, hidden continuous variable F* influencing the value of F. The probit model was employed to examine how the technical efficiency of poultry egg producers impacts food security, which was evaluated using household food insecurity access scales and household dietary variety ratings in the study region. As Obi-Egbedi and Ifoga (2023) show, the probit model can be formally portrayed as

$P(Y = 1/X) = \Phi(X\beta)$ (1)
Where:
Independent variable vector is X.
Coefficients in the vector β
Φ = cumulative distribution function (CDF) of the standard normal distribution
We hypothesize that an observed (latent) variable Y* will define the observed binary outcome:
Y^*=Xβ+ε
Thus,
Where: ε = N (0, 1)
Y is a food security level.
1 otherwise; food secure for household that did not report any of the three domains of food insecurity; 0 (Villacis et al, 2023; Ukonu et al, 2023; Afodu, Balogun, Afolami, Akinboye, Akintunde, Shobo, Adewumi, Ayo-Bello, Ndubuisi-Ogbonna, Oyewumi, and Adefelu, 2024)
The model's explanatory variables (Xs) comprise: X1 = Age (in years), X2 = Household Size (in numbers), X3 = Education Level (years of formal education), X4 = Contact with extension agent (Yes =1, No = 0), X5 = poultry farming experience (in years), X6 = Membership of farmers' group (Yes =1, No = 0), X7 = Amount of Credit obtained (in Naira), X8 = Technical efficiency score (in number), b = Vector of parameters, ε = error term.

Results and Discussion: Socio-economics characteristics of the poultry egg farmers: Table 1 provides a summary of the socioeconomic features of the chicken egg producers in the sample. A significant 80.60% of them were men. The resource-heavy character of the poultry egg project, often more manageable for men, may explain this discovery. This result is in line with Akinyemi, Ekpa, and Adeosun (2019) study, which revealed more male poultry egg farmers than women. Given that 76% of the poultry farmers surveyed were married, married farmers are also likely to support one another financially and non-financially when running their poultry operations. This supports the findings of Zelda and Obiajunwa (2022), who discovered that married poultry farmers were more common than single farmers. The average age of poultry egg farmers was 44 years, which indicates that they are at their prime and rather young. This means one will have a greater tendency to take chances and welcome efficient methods and new technologies. Johnson et al. (2020) state that since younger poultry egg producers are more active and ready to try out new technology, they are more resilient to the problems of egg production. This result is consistent with their results. Furthermore shown by the results was that farmers had nine years of farming knowledge on average. Regarding productivity and efficiency, this means the farmers will be able to make well-informed choices that would help their farm as a whole. This result reinforces the findings of Odimegwe, Babatunde, Ogbonso, and Ambode (2015) that poultry egg farmers in their study had an average years of farming experience of 9 years. Moreover, the findings showed that while practically three-fifths of the farmers claimed receiving credit, the remaining two-fifths did not. The results also showed that the typical farmer made ₦ 450,000. This suggests that the farmers who got the loan would probably employ more efficient poultry keeping practices even if the loan was little. According to Ojo, Amos, and Oluwatayo (2024), this finding supports the notion that value or credit earned is vital when manufacturing for the market even if credit obtained may not be enough owing to its small size relative to the growing cost of production. Moreover, the findings revealed that the average farmer in the study region kept 459 birds. This implies a somewhat little flock size, possibly connected to high production expenses—notably for feed. Both in quantity and quality, low levels of production might not provide enough cash to buy sufficient food. Previously, Zelda and Obiajunwa (2022) noted a link between tiny flock numbers and low returns.

Distribution of poultry egg growers according of efficiency level: Table 2 reveals the dispersion of poultry egg producers according to efficiency rating. With an average technical efficiency of 0.73, poultry egg producers are technically efficient; however, the results also imply they may create more using their current input levels, hence pointing to room for improvement. Among Kwara State, Nigeria participants in their study, Adewumi and Animashaun (2014) found an average technical efficiency of 0.71.

Distribution of poultry egg farmers by experienced-based food security: Figure 1 reveals the distribution of poultry egg producers by food security related to experience. The numbers reveal that only 31% of the farmers are food secure, which means they are not concerned about running out of food. Mild to moderate food insecurity was reported by fifty-five percent of them; they used many coping methods. But the other 14% suffered severe food insecurity, which suggests they were in a vulnerable situation where they might not consume for a whole day. These results highlight the need that sufficient income supported by high technical efficiency plays in ensuring constant access to enough food in accordance with Ojo et al. (2025), who discovered that about 38% of pig farming households were food secure while others had various levels of food insecurity.

Arrangement of the farmers by the food group they ate: The distribution of farmers by meal group is shown in Figure 2. The most often consumed food groups by the farmers were cereals and roots and tubers (about 89%), followed by miscellaneous foods which consist of spices and sauces consumed by 81.2%. Also, 79.8% of the farmers reported eating oil, while 71.2% reported eating vegetables. Moderate quantities of sweets, seafood, eggs, and legumes—among other food groups—were eaten. By contrast, the farmers ate hardly any meat, fruit, or dairy products. This eating pattern impacts leading a balanced and successful life. These outcomes might be explained by seasonality, financial factors (accessibility), and cultural tastes. This conclusion is supported by the results of Ukonu et al. (2023), which found that grains, roots, and tubers were the most frequently eaten food categories in families they examined.

Mean household nutritional diversity of poultry egg farmers divided by Technical Efficiency quartile: Figure 3 shows the link between poultry egg farmers' technical efficiency scores and their households' average dietary diversity. The findings revealed that as technical efficiency scores increased, so did dietary diversity. This indicates that farmers with greater technical efficiency often eat more variety. One possible explanation for this finding is that the less efficient farmers manufacture more with fewer input levels than more efficient ones do technically. Farmers with technical efficiency scores between quartiles 1 and 2, on the other hand, had dietary diversity scores lower than the 6.7 average recorded in the study. The higher earnings brought about by this boost in productivity enable the purchase of a greater range of food products. Sarma, Alam, Begum and McKenzie (2024) discovered a positive link between technical efficiency and dietary diversity at the household level in a past research. This result, on the other hand, goes against the findings of Adewumi and Animashaun (2014), who discovered that technological efficiency lowers food variety in homes.

Results of probit regression analysis: The efficiency score coefficient in table 3 indicated a positive and significant association with food security at the 5% level, implying that more technically efficient poultry farmers are, more secure their food condition is. This might be because more effective poultry producers use fewer resources to create more output, therefore lowering costs and boosting revenue or profit margins, which in turn improves their access to a range of foods. Less efficient agricultural households were less likely to be food secure than their more efficient counterparts, according to Oyetunde-Usman and Olagunju (2019). Interactions with agricultural extension experts also shown in the study at the 10% significance level that food security was favourably and greatly affected. This study found that poultry farmers who cooperate with agricultural extension agents are more likely than those who do not to reach food security. One of the causes of this might be the training given by agricultural extension agents, which promotes the use of cutting-edge agricultural technologies that could raise output. Having access to agricultural extension services helps food security in general, according studies by Onwuaroh, Waziri, Tata and Nwunuji (2024) and Ajayi and Olutumise (2018).

Experience in poultry egg farming also had a favourable and significant effect at the 5% level on food security. This implies that more knowledgeable poultry egg farmers are more inclined to be food secure than their less experienced colleagues. These results are consistent with the study conducted by Abanigbe, Ngidi, Ojo, Oyedeji-Amusa, Orowole, Yusuf-Oshoala and Adebayo (2024), which found that experience had a favourable and significant effect on small-scale poultry farmers' food security: Moreover, at the 10% level, the positive coefficient associated with the amount of credit obtained by poultry egg producers greatly affected food security. This result is in line with Ma-Azu (2015) conclusions, which revealed that Ghanaian poultry farmers benefited greatly from the credit received. But the household size coefficient was negative and substantially affected food security at the 5% level, suggesting that smaller chicken farming households are less likely to have food security than bigger ones, perhaps as a result of the pressure on available food supplies in bigger households, hence resulting in insufficient per capita food consumption. The findings of Ojo et al. (2025) also support this result; they discovered that greater family sizes were related to food insecurity in pig farming communities.

Conclusion/ Recommendations: The results of the study indicate that the more efficient farmers are more able to diversify their diets as proven by the positive correlation between technical efficiency and household dietary diversity ratings, with an average technical efficiency score of 0.73. Almost a third of the farmers were food secure, while others said they were concerned about their food availability to the point that they ate smaller portions, missed meals, or, in the worst cases, went without food for the whole day. These results emphasize the need for focused treatments. The findings further indicated that roots and tubers, miscellaneous, oils and vegetables as well as cereals were the most typical food sources for the farmers. Moreover, the nutritional variety scores of farmers in the lowest efficiency quartile were lower than the study's average. The results of the probit regression study also showed that household size, farming experience, technical efficiency, access to agricultural extension services, and credit obtained all had a significant impact on food security outcomes. Household size has a negative and significant influence on food security among these farmers but technical efficiency, interaction with agricultural extension agents, farming experience, and credit obtained have a positive and significant impact. The study emphasizes how crucial it is to raise farmers' technical efficiency in order to increase access to food and increase food security. Addressing particular farmer requirements requires bolstering agricultural extension services with the assistance required for more efficient service delivery to farmers to enhance their capacity through training. Additionally, expanding family planning programs to address large family size issues is a practical way to reduce food insecurity, and making credit delivery through group lending would promote the adoption of better practices and technologies, leading to enhanced technical efficiency and increased output/income and ultimately better access to food in terms of quality and quantity. Therefore, these crucial elements should be emphasised in policies and initiatives aimed at improving food security for poultry egg producers.

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Appendix

Table 1: Socio-economics characteristics of the poultry egg farmers

Variables	Frequency	Percentages	Mean	SD
Age (years)				
Less than or equal to 30	27	15		
31-40	42	23	44	15.14
41-50	63	35		
51-60	25	14		
Above 60	23	13		
Gender				
Male	145	80.6		
Female	35	19.4		
Marital status				
Single	44	24		
Married	136	76		
No of birds				
≤250	24	13		
251-500	82	46	459	186.38
501-750	61	34		
751-1000	13	7		
Farming experience				
Less than 1	17	9		
1-5	23	13		
6-10	84	47	9.44	2.51
11-15	42	23		
Above 15	14	8		
Amount of credit obtained (₦'000)				
0	73	41		
≤250	26	14		
251-500	41	23	450,000	223,000
501-750	24	13		
751-1000	16	9		

Source: field survey, 2024

Table 2: Distribution of poultry egg farmers by efficiency score

Efficiency score	Frequency	Percentage	Mean

0.391 – 0.490	11	6.1	
0.491 – 0.590	25	13.9	
0.591 – 0.690	31	17.2	0.73
0.691 – 0.790	42	23.3	
0.791 – 0.890	46	25.6	
0.891 – 0.990	25	13.9	

Source: field survey, 2024

Table 3: Estimate of probit regression analysis

Variables	**Coefficient**	**Z**	**p>|z|**
Constant	-1.6756 (0.6690)	-2.50	0.012
Efficiency score	3.9985 (1.4790)	2.70	0.007
Years spent in school	-0.1634 (0.3085)	-0.53	0.596
Contact with extension agents	1.7738 (0.9948)	1.78	0.075
Age	-0.04527 (0.04936)	-0.92	0.359
Farming experience	0.3107 (0.1439)	2.16	0.031
Membership of farmers' group	0.4494 (1.0203)	0.44	0.660
Amount of Credit obtained	0.0000 (0.0000)	1.83	0.067
Household size	-0.4176 (0.1885)	-2.22	0.027

Number of observation = 180
LR chi^2(8) = 222.33
Prob > chi^2 = 0.0000
Log likelihood = -9.9762712
Pseudo r^2 = 0.9176

*, **, *** represent 10%, 5% and 1% level of significance respectively; standard errors are in parenthesis

Source: field survey, 2024

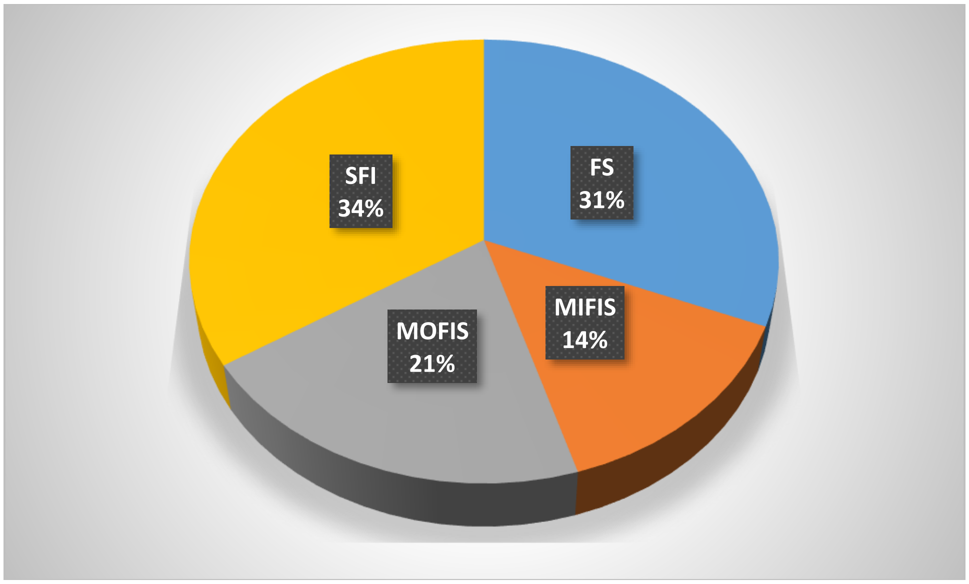

Figure 1: Distribution of poultry egg farmers by experienced-based food security
Source: field survey, 2024

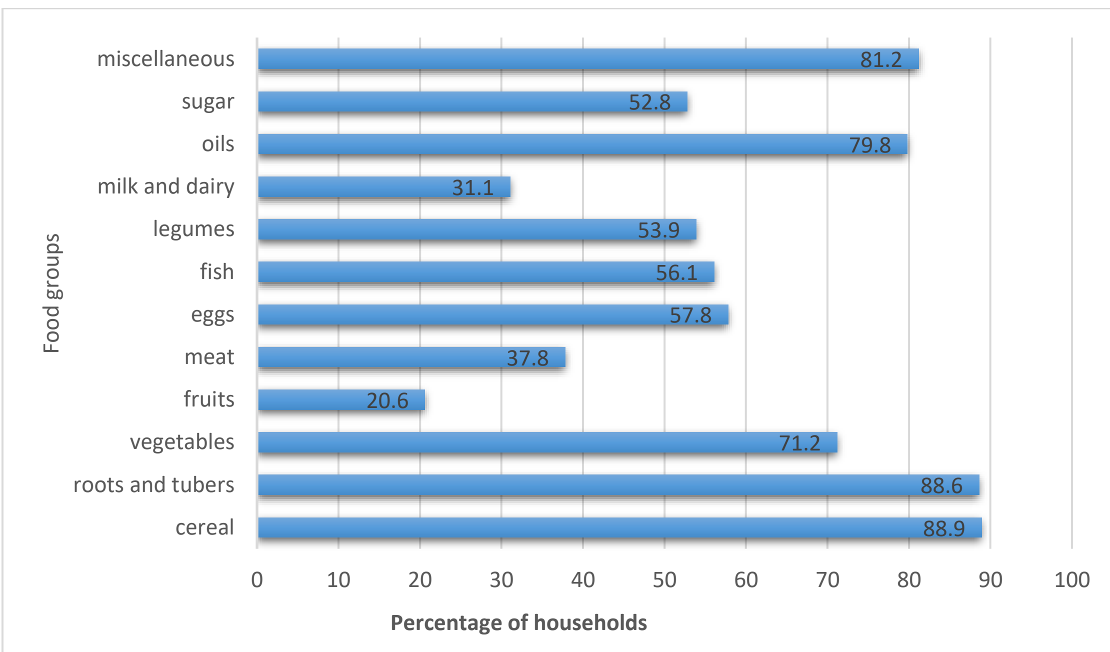

Figure 2: Distribution of poultry eggs farmers by food groups
***Multiple responses**
Source: field survey, 2024

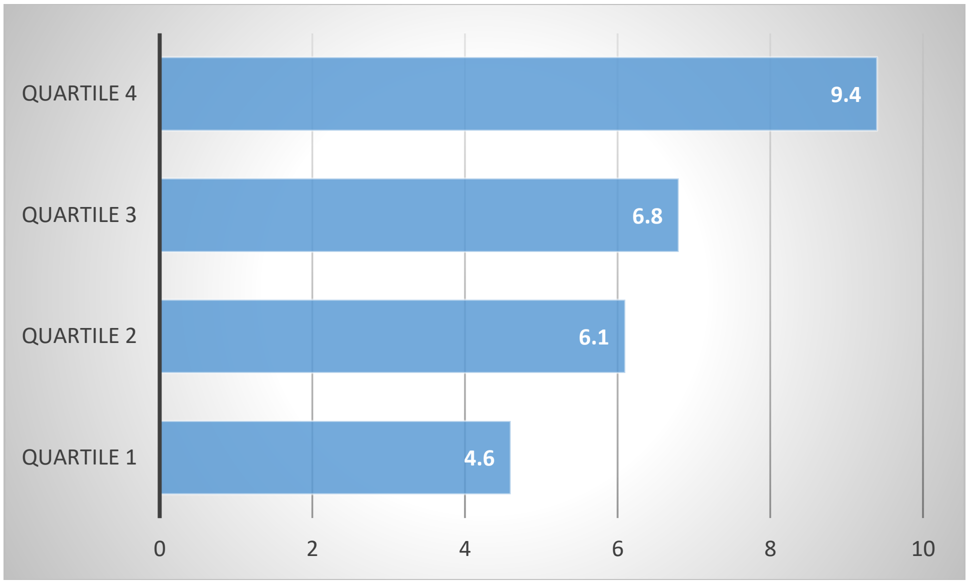

Figure 3: Distribution of mean household dietary diversity of poultry egg farmers by Technical Efficiency quartile
Source: field survey, 2024