



Effects of rabbit production on income and livelihood of rural households in Nigeria

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ARTICLE INFO

Keywords:

Constraint
Livelihood
Rabbit farming
Rural households

ABSTRACT

Aims: More effort and actions are needed to combat the rising levels of food insecurity and poverty in developing countries, particularly among rural households. Rural households can significantly contribute to reducing poverty, enhancing their nutritional condition, and enhancing their standard of living by engaging in rabbit production but there are few empirical studies on the contribution of rabbit production to households' livelihood and income. Therefore, this study examines how producing rabbits affects rural farmers' income and household livelihood in Nigeria.

Methods and results: Multiple regression and descriptive statistics were used to analyze the data gathered from 240 rabbit farms. The findings demonstrated that rabbit farming is a male-dominated enterprise (male 77.5%). According to the regression analysis, the income of rural households was positively and significantly impacted by the income from rabbits. Farmers' ages, interactions with extension agents, credit they accessed, and assets were further determinants of their income. Additionally, rabbit production improved the level of living of rural households. Access to forage, the prevalence of diseases, scarcity of veterinary, and the high cost of medication, were the severe constraints faced in rabbit production.

Conclusions: It may be concluded that rabbit production had a significant contribution to the economic situation, way of life, and well-being of rural households. Although there were some constraints with the operation. Females are to be encouraged in rabbit production as livelihood diversification. Also, it is crucial that banks, governments, and non-governmental organizations offer farmers easily accessible and reasonable loan facilities as this will boost their revenue. Training on forage production and storage is also recommended.

Significance and the impact of the study: Participation will be improved by having an understanding of how rabbit farming affects the income and way of life of rural dwellers. As a result, the findings of this study would enable policymakers to intervene in enhancing its production thereby encouraging more farmers to be involved in the production and also, enhancing the well-being of rural households.

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<https://doi.org/10.1016/j.heliyon.2023.e18568>

Received 31 October 2022; Received in revised form 4 July 2023; Accepted 20 July 2023

Available online 24 July 2023

2405-8440/© 2023 Published by Elsevier Ltd.

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1. Introduction

Given that Sub-Saharan Africa is home to more than 56% of the world's extremely poor people, poverty levels there are on the high side [1,2]. As a country with a 40.1% poverty rate [more than 85 million people], Nigeria is not immune to this threat [3].

In general, agriculture plays numerous significant roles in Nigeria's economic development, especially in reducing poverty. Agriculture continues to be the backbone of the Nigerian economy.

Farmers who rely on small-scale farming as their primary means of subsistence make up a larger proportion of the world impoverished. As a result, the expansion of agriculture is promoted as a crucial and successful global strategy for reducing poverty [4,5,6,7].

One of the main drivers of the rural and national economies, and of special relevance to the poor, is livestock raising. Pica-Ciamarra et al. (2015) recognize that livestock keeping diversifies production and lowers the risks of economic losses due to crops destroyed by unfavorable climatic conditions or diseases [8].

Researchers and policymakers continue to place a high priority on the need to lower the high prevalence of poverty and food insecurity, particularly in rural Sub-Saharan Africa [9]. 811 million people worldwide are food insecure [10]. More than 250 million people in Africa are undernourished, with 239.1 million of them living in Sub-Saharan Africa alone. Food insecurity and undernourishment are thus continuing to rise within this region [10].

According to Omondi et al. (2017), livestock serves a variety of vital functions, such as providing employment for farmers and their families, serving as a kind of insurance, serving as a store for wealth, and promoting gender equality by creating possibilities for women [11]. Livestock ownership may serve as the foundation for the observance of a religious ritual or as a means of determining a farmer's status [8]. Raising livestock production can also increase households' income and standard of living [12].

One of the few economic opportunities available to the impoverished in developing nations is livestock raising [8,13]. Small cattle provide less financial risk than large livestock because they require less initial investment [14,15].

According to a study by Panin and Mahabile, (1997) on the financial value of livestock to smallholder farmers in rural Botswana, households with small ruminants typically earned \$11.27 per animal on average, or 34% of their initial investment and contributed an additional 15% to the household income [16].

Researchers have discovered that one of the main methods used by low-income households for asset building is poultry production [17]. The selling of chicken and poultry products gives families the funds to purchase essentials and is considered as an empowerment strategy [18,17].

In many developing nations, raising rabbits is a vital source of income. Numerous research from African nations have discovered that rabbit production strongly affects a number of rural household livelihood indicators, including income, food and nutrition security [19,20]. The smallholder farming community can greatly benefit from micro-livestock production because it has the advantage of producing small, quickly growing animals for meat and other uses [21].

At first, raising rabbits was a hobby or a way to make a living. However, with time, there has been a transition in rabbit production from non-commercial to commercial [22]. In this context, commercialization refers to the transition from subsistence to commercial agriculture.

The following factors make rabbit farming sustainable in poor nations. Rabbits can first be grown on a diet free of grains. The ability to raise a good protein on garden fodder is advantageous in developing nations because of rising food prices and rising demand for grains. Rabbits are known for their quick growth rates, high fecundity, high feed conversion rates, and early maturity. When properly cared for, rabbits can produce more than 40 kits a year, compared to a calf for a cow and up to two youngsters for a goat [23]. Also, in contrast to many of the larger ruminants, rabbits are said to be odorless, noiseless, and capable of adapting to a variety of habitats [24].

There are several benefits embedded in the production of livestock for the producers and their households [25,26,13,27,28]. In poor rural households throughout the developing world, there is significant evidence that keeping livestock improves nutrition, enhances economic stability, and lowers gender inequities [29,27,30,31].

This evidence focuses a lot on large animals like cattle [32], which typically require substantial capital investment, labor, as well as access to suitable pastures. These barriers prevent the poor from participating. Other studies [33,24,23,34,35], on small livestock production in Nigeria, are majorly focused on profitability, efficiency and marketing of rabbits. There is limited research examining how the engagement in rabbit production affected the households' livelihood and income. Hence, the need for this study.

This study seeks to provide answers to the question of: what are the contributions of rabbit income to the households' livelihood? Specifically, this study describes the socioeconomic characteristics of respondents, evaluates the effects of rabbit income on the households' total income, examines the effects of rabbit production on household livelihood and identifies the constraints to rabbit production in the area.

This study adds to the body of knowledge by supplying factual information of the effects of rabbit production on rural households and the major drivers of their production income. This evidence will serve as a guide for agricultural policy and planning in the design of small livestock intervention targeted at improving the rural sector.

2. Methodology

2.1. Study area

This study was conducted in Nigeria using three states: Ogun and Oyo state from the Southwest, Kwara state from the North Central. Ogun, Oyo, and Kwara State are three states with significant agricultural production in the country. Ogun State was the 16th

most populous state in Nigeria in 2006 with a total population of 3,751,140 people. Ogun State has a total size of 16,762 km², making it the 24th largest state in Nigeria by landmass [36]. Additionally, the state's livestock industry is growing due to the presence of adequate forest reserves on 20% of its total land area [37].

Oyo State is an inland state in the southwest of the nation with a total area of about 28,454 km². With a population of 7,840,864 in 2006, Oyo State is the fifth most populous in Nigeria. Kwara state, with about 36,825 km² land area, is situated in the north-central region of the nation.

Geographically, Kwara is split between the West Sudan savanna in the east and the Guinean forest-savanna mosaic eco-region in the rest of the state Fig. 1.

2.2. Sampling technique

The selection of the sampled rabbit farmers who contributed to the study's data involved a multi-stage sampling process. In the first stage, three states were chosen at random (Ogun and Oyo State from the South-west and Kwara State from the North-central geopolitical zone). The number of rabbit farmers chosen in each state was determined in the second step using the Yamane (1967) formula (with a 90% confidence level and a 45% estimated proportion of the unit population) [38]. In the third stage, the probability proportionate to size (PPS) method was used to estimate the number of rabbit farmers by state, and 240 rabbit farmers were chosen from the list of registered rabbit farmers with the Rabbit Farmers and Breeders Association of Nigeria (RFABAN) in the three states.

2.2.1. Data collection procedure

Data collected were through a semi-structured questionnaire [Appendix 1], together with an interview schedule-guide. Interview

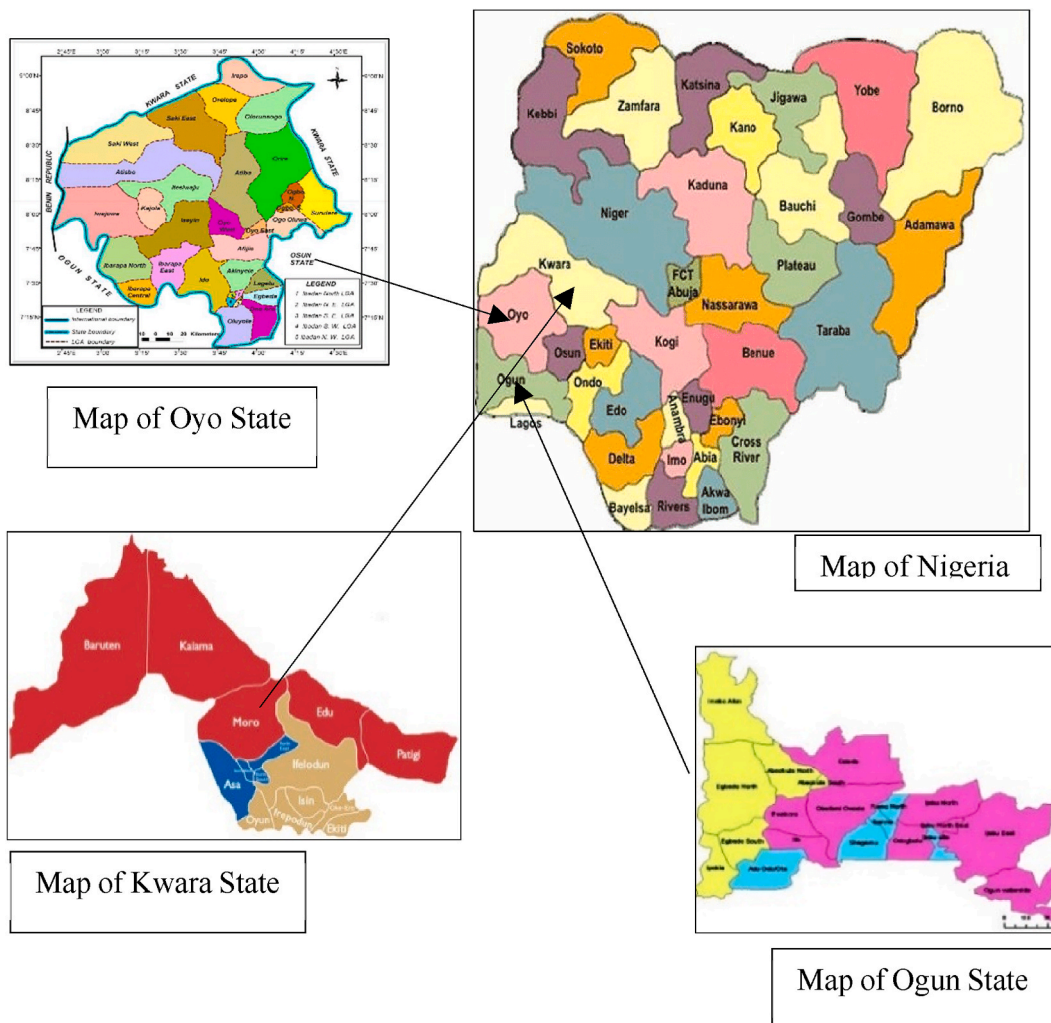


Fig. 1. Map showing the study areas. Source: UN cartographic section: Available from <https://www.nationsonline.org/oneworld/map/nigeria-administrative-map.htm> accessed on September 26, 2022.

schedule was included to aid the collection of the required information from the rabbit farmers. The data were collected by the researchers and research assistants who understand the local languages for easy communication with the rabbit farmers. Data collected covered relevant information such as their demographic, institutional, social and economic features, and information about income from rabbit production.

2.2.2. Ethical approval

The informed consents of all participants of the research were sought before being surveyed. Participation in this study was also voluntary. The respondents were asked to indicate their willingness to participate in the study and also, they are to append their signature on the questionnaire to indicate their voluntary willingness to participate (Appendix 1).

2.3. Empirical models and estimation procedures

To achieve the study objectives, the data were analyzed using three analytical methods. First, the socioeconomic attributes of the rabbit farmers were described using descriptive statistics. Second, to investigate the variables influencing rabbit farmers' income, and identify other determinants of rabbit income, multiple regression was utilized. Third, a five-point Likert scale score was used to examine farmers perceptions on the contributions of rabbit farming to their livelihood and the to highlight the challenges faced by the farmers.

2.3.1. Conceptual framework

To achieve the study objective of measuring the effects of income from rabbit production on the farmer's total income, following Falola et al. (2014), we assume that smallholder total income is a function of farmers' demographic characteristics, farmers' assets, farm-specific characteristics and institutional factors [39] as follows:

$$Y = \beta_0 + \beta_2FD + \beta_3FA + \beta_4FI + \epsilon \tag{1}$$

Where:

Y = Farmers annual Income (Naira), FD = farmers demographic characteristics (age, household size), FA = Farmers Asset (Asset, loan), FI = Farmers Institutional characteristics (membership of Institution or Social network, extension contact, Veterinary, contact), β_0 = Constant,

$\beta_1 - \beta_{10}$ = Coefficients, ϵ = Error term.

We estimated the effect of rabbit production income on farmers' total income, adopting Mukaila et al. (2022). Rabbit income is expected to increase the total income, hence, we link the rabbit income to the total income through a linear function [9]. It can be specified as:

$$Y = \beta_0 + \beta_1RY + \beta_2FD + \beta_3FA + \beta_4FI + \epsilon \tag{2}$$

Where the newly introduced RY is the annual rabbit income.

The magnitude and the direction of the rabbit income parameter, β_1 would be accurately estimated as the measure of the impact of rabbit income on the farmers' total income Y.

2.3.2. Estimating the variables that influence rabbit farmers income

To investigate the variables influencing rabbit farmers' income, and identify other determinants of rabbit income, the explanatory variables were selected based on empirical evidence of agrarian livelihood diversification literatures [19,40,39]. Following Fadipe et al. (2014), multiple regression was utilized [40]. OLS, or ordinary least squares, is employed when the dependent variables are continuous.

2.3.3. Model specification for the effect of rabbit income on total households' income

$$Y = \beta_0 + RY\beta_1 + A\beta_2 + HS\beta_3 + ED\beta_4 + FX\beta_5 + S\beta_6 + EC\beta_7 + VC\beta_8 + CR\beta_9 + M\beta_{10} + \epsilon \tag{3}$$

Where: Y = Annual Income [Naira] RY = Rabbit annual Income (Naira) A = Age (Years) HS = Household size (Number) ED = Level of education of the farmer (year) FX = Farming experience in rabbit farming (Years) S = Asset (Naira) EC = Number of extension contacts VC = Number of Veterinary contact CR = Amount of credit access in the year (Naira) M = Membership of Cooperative Society (1 = Yes, 0 = No) β_0 = Constant, $\beta_1 - \beta_{10}$ = Coefficients ϵ = Error term

2.3.4. Apriori expectations for the explanatory variables used in the model

Rabbit Production on Income and Livelihood.

Variables	Definition and Measurement	Expected signs
Y = Annual Income [Naira]	Total annual Income generated from all enterprises of the farmer measured in Naira	

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Variables	Definition and Measurement	Expected signs
RY = Rabbit annual Income [Naira]	Total annual Income made from rabbit production, measured in naira	+
A = Age [Years]	Age of rabbit farmer head in years	+/-
HS = Household size [Number]	Household size in number	+/-
ED = Level of education of the farmer [year]	Years of education of the rabbit farmer	+
FX = Farming experience in rabbit farming [Years]	Number of years in rabbit farming	+
S = Asset [Naira]	Naira value of the total assets the rabbit farmer possessed	+
EC = Number of extension contacts	Number of times the farm was visited by extension officer [s] in the last production	+
VC = Number of Veterinary contact	Number of times the farm was visited by Veterinary doctor [s] in the last production	+
CR = Amount of credit access in the year [Naira]	Amount of credit the rabbit farmer received in the last production in Naira	+
M = Membership of Cooperative Society [1 = Yes, 0 = No]	Cooperative society the rabbit farmer belongs to. [1 = Yes, 0 = No]	+

2.3.5. Likert type scale

A five-point Likert scale score was used to examine how farmers' perceptions of how producing rabbits have improved their livelihood and to highlight challenges encountered in rabbits production as it was used by previous researchers [9].

Farmers were asked to rate the significance of a list of benefits according to how important they believed each one to be. The scale goes from strongly agree (5), agree (4), undecided (3), agree (2) to strongly disagree (1). The average score of the respondents on each item was determined, with a mean score of 4.0 serving as the cutoff criterion for determining if a benefit is significant. Any restriction having a mean value equal to or higher than 4 was regarded as a severe constraint, whereas constraints with a mean value below 4 were not. The listed benefits were ranked according to their significance using the weighted score and mean.

Constraints faced by the farmers in rabbit production were also ranked according to their percentage as selected by the farmers.

3. Results and discussion

From Table 1, the majority (77.5%) of the small-scale rabbit Farmers are male, with very few females. This may be due to the high risks involved in some livestock business; women are not good at taking risks as reported by previous study [41]. The implication of this result is that although the risk involved in rabbit production is relatively lower than other livestock production like poultry, it is still viewed as a risky livestock business. About 79.6% of the respondents are married, and 20.4% are single. The increased ratio of married people suggests a high probability of family labor availability for raising rabbits in the study areas. The outcome also reveals that 52.1% of the household size modal group falls under 5–8. Income diversification is expected to be increased with a large household regarding labour supply for off and on farm. This result is consistent with previous study [42]. This implies that family labor is likely to be available in the research area, other things being equal. The amount of family labor that can be used on a farm depends on the size of the family. Additionally, the results demonstrate that 47.1% of smallholder rabbit growers are educated beyond high school. HND/ND, NCE, and bachelor's degrees are all included in this educational level. 7.9% of the respondents only have primary education. The high levels of education would help them handle resources in their firm more effectively. It may also have a favorable impact on the farmers' acceptance of new technologies and access to important information that could boost their output. Table 1 also demonstrates that the average age of farmers is 37.1 years, with 40.4% of them being between the ages of 31 and 40. With a mean age of 37.1, this indicates that the majority of responders are farmers in their middle years. They are in the active age range and are still quite young. They fall under the FAO's definition of the economically active population, which is defined as people aged 25 to 59. With a mean of 5.0 years, a majority (81.7%) of the respondents have experience in rabbit farming for less than 6 years. This could be because of the public awareness of rabbit meat importance which led to the recent increases in the preferences for rabbit meat. The implication of this finding on the year of experience is that their level of experience would affect the effective abilities in the application of any technical advance that are related to farming experience.

The majority (73.3%) of the respondents raised between 6 and 205 rabbits in the last production year, while the minority (0.8%) raised more than 506. The average number of rabbits farmed is 185, indicating that rabbit farming in the research area is a modest industry and still evolving. This is in line with the findings of previous study [43]. The implication of this result is that, there exists a great opportunity for the growth of rabbit production in Nigeria. The majority (65%) of respondents have other employment as their primary occupation, while 35% of them report farming as their main job, according to the data. This may be a way for small-scale rabbit farmers to diversify their sources of income, and it is an effective safeguard against hardship for those who make less money. Those with low incomes or wage employees who have no alternative source of income are frequently at risk of poverty [44].

The outcome shows that most respondents had access to less than N100, 000 (\$153)¹ in credit at some point or another for their rabbit-related operations in the last production year. This suggests that they could be unable to enhance their farming activities when required. Previous studies pointed out that access to credit was a major constraint to rabbit farmers in expanding their production [33, 45].

In addition to being a member of the Rabbit Farmers and Breeders Association of Nigeria (RFABAN), about 75.8% of the

¹ USD = 653.5 Nigeria Naira.

Table 1
Socioeconomic Characteristics of Rabbit farmers.

Characteristics	Frequency (n = 240)	Percent	Mean
Gender			
Female	54	22.5	
Male	186	77.5	
Marital status			
Single	49	20.4	
Married	191	79.6	
Household size (number)			
≤ 4.0	112	46.7	
5.0–8.0	125	52.1	
9.0+	3	1.3	5
Education level			
primary education	19	7.9	
secondary education	108	45	
tertiary education	113	47.1	
Age (Years)			
≤ 30.0	70	29.2	
31.0–40.0	97	40.4	
41.0–50.0	55	22.9	
51.0–60.0	15	6.3	
61.0+	3	1.3	37.1
Farming Experience (Years)			
≤ 6.0	196	81.7	
7.0–10.0	30	12.5	
11.0–14.0	2	0.8	
15.0–18.0	2	0.8	
19.0–22.0	7	2.9	
23.0–26.0	1	0.4	
27.0+	2	0.8	5.0
Primary occupation			
Farming	84	35	
Non-farming	156	65	
Number of stock (head)			
6.0–105.0	84	35.0	
106.0–205.0	92	38.3	
206.0–305.0	33	13.8	
306.0–405.0	15	6.3	
406.0–505.0	11	4.6	
506.0–605.0	2	.8	185
606.0+	3	1.3	185
Amount of credit accessed (Naira)			
≤ 100000.0	211	87.9	
100001.0–300000.0	20	8.3	
300001.0–500000.0	6	2.5	
700001.0–900000.0	2	0.8	
900001.0+	1	0.4	43,342
Cooperative Membership			
No	58	24.2	
Yes	182	75.8	

Source: Field Survey, 2022.

respondents also belong to other cooperative groups. This suggests that they have additional ways to obtain loans, market their goods or buy materials in large quantities, and gather information about their operations, all of which can help to lower overall operating costs. Also, with a majority being a member of cooperative society, it will be easy to pass information on new technology to the farmers by extension agents.

The lead equation's coefficient of multiple determinations (R^2) as shown in Table 2 is 0.876. This shows that the function explains around 87% of the dependent variable in the regression. It demonstrates that given a percentage change in the small-scale rabbit farmers' yearly household income, rabbit income will change, while the household head's age, education level, and level of farming experience will not. The amount of credit accessed, the veterinarian contact, the extension contact, and the asset value will all change.

It can also be seen from Table 2 that Rabbit income significantly contributes to overall household income. As a result, if other factors remain constant, a 1% increase in rabbit income will result in a 1.96% increase in the level of household income.

The result also shows that the age of the household head was also significant and had a positive coefficient, suggesting that ageing may help people learn skills that lead to more efficient output and higher incomes.

Concerning overall revenue, Table 2 shows that the quantity of credit accessible had a positive correlation [$p = 0.01$]. The outcome indicates that a unit increase in credit accessibility will result in a 1.1% rise in household income. This suggests that having access to credit raises the revenue of farmers who raise rabbits because it increases the farmers' capital invested in their farming operations. This

Table 2
Ordinary least square result of effects of rabbit income on total households' income.

Variable	Coefficient	Standard Error	t-value	p-value
(Constant)	5.84 ^a	0.034	170.176	0.000
Rabbit Income (Naira)	1.96E-07 ^a	0	27.198	0.000
Age (Year)	0.002 ^a	0.001	1.985	0.049
Household size (Number)	-0.003	0.003	-1.168	0.244
Education level (Year)	0.006	0.008	0.745	0.457
Farming Experience (Year)	0	0.001	0.228	0.82
Farming association (Yes = 1; No = 0)	0.018	0.013	1.352	0.178
Amount of Credit accessed (Naira)	1.13E-07 ^a	0	2.647	0.009
extension (Number)	0.009 ^a	0.004	2.199	0.029
Veterinary contact (Number)	0.002	0.002	1.134	0.258
value of asset (Naira)	1.15E-07 ^a	0	16.806	0.00
R ² = 0.876				
F = 154.153				

Source: Field Survey, 2022.

^a Significant at 1%, ** Significant at 5%, * Significant at 10%.

result is in consonant with the previous findings [39,46].

Extension contact was also significant with a positive coefficient. This is expected because extension contacts will increase the knowledge base of the farmers on efficient production thereby increasing their profit. This result is in agreement with the result previous study [47]. Also, the contact with Veterinary and the value of assets positively contributed to the household income of rabbit farmers.

3.1. Effect of rabbit production on the livelihood of the rural farming households

Table 3 presents the effects of rabbit production on the livelihood of rabbit producers.

More than half of the farmers firmly agreed that raising rabbits boosted the amount of food that was available to their families; which supports the findings previous study [19]. The farmers' food security will be improved since they could buy other foods from the income from rabbit farming. Also, most farmers fervently concurred that raising rabbits improved their nutritional quality. Because it is well known that eating nourishing foods is just as important as consuming appropriate food. Utilizing the nutrients in rabbits will boost their nutritional condition by giving their body a variety of nutrients that support a healthy life. The result also reveals that most of the farmers were able to send their children to school and raise their standard of living from the revenue generated by the production of rabbits. The farmers acknowledged that raising rabbits enabled them to save money for a future goal.

Further investigation showed that six of the eight claimed advantages of rabbit farming had mean scores higher than the Likert score mean [4.6]. This shows that the majority of the advantages associated with raising rabbits were significant and practical, at least according to the farmers. These findings suggest that rabbit production boosted the livelihood of rural farming households and had a favorable impact on their way of life.

4. Constraints in rabbit production

Table 4 shows the distribution of constraints faced by farmers in rabbit production. Access to forage [25%] is the most prominent constraint, followed by the prevalence of diseases [20%], while High cost of feed, access to finance, and abortion were the least constraints. These constraints were also reported as the major constraints faced by rabbit farmers by a previous study [19].

5. Conclusion and recommendations

This study analyzed how rabbit production affects household income and livelihood. We used multiple regression and descriptive

Table 3
Perceived effects of Rabbit farming on the livelihood of rural households.

Benefits	S.Agree %	Agree %	Undecided %	Disagree %	SDIS.%	Likert Mean
Provision of Daily income	88.75	8.75	2.5			4.86
Meeting Basic need	82.917	17.083				4.83
Improved Nutrition	87.917	7.500	4.583			4.83
Employment	92.08	7.92				4.92
Increase food availability	59.583	21.667	18.750			4.41
Increased Savings	53.333	21.667	7.917	17.083		4.11
Payment of children's School fees	78.333	18.750	2.917			4.75
Improved living standard	81.25	14.58	4.17			4.77

Source: Authors' computation from field survey, 2022; S.A. = strongly agree, Und. = undecided, SDIS. = strongly disagree.

Table 4
Percentage distribution according to constraints in rabbit production.

Challenges	Frequency	Percentage
Access to forage	60	25
Prevalence of Diseases	48	20
Scarcity of Veterinary Doctors	36	15
High Cost of Medications	36	15
Poor Extension	24	10
Abortion	12	5
Access to Finance	12	5
High Cost of Feed	12	5

Source: Authors' computation from field survey, 2022.

statistics to see the impact of rabbit income on household income and to identify the drivers of households' income. The findings demonstrated the income of rural households was positively and significantly impacted by the income from rabbits. Farmers' ages, interactions with extension agents, credit they accessed, and assets were further determinants of their income. Additionally, rabbit production improved the level of living of rural households. Access to forage, the prevalence of diseases, scarcity of veterinary, and the high cost of medication, were the severe constraints faced in rabbit production.

The study concludes that the production of rabbits had a significant impact on rural household income, economic position, livelihoods, and well-being. Therefore, raising rabbits is crucial for rural farmers' income, improving the economic situation and standard of living for rural households, and it may be used as a strategy to enhance living conditions, combat poverty, and lessen malnutrition and food insecurity in rural regions. Farmers had to contend with constraints such as access to pasture, the prevalence of diseases, a lack of veterinary services, and the high cost of medication despite the importance of rabbit production.

From a policy perspective, there is a need to.

1. .
2. Although rabbit income contributions to the household income was significant, the magnitude of the contribution is low. Addressing the constraints to rabbit production as listed by the farmers will enhance better contributions of rabbit income to the household income.
4. The study found that credit access by the farmers increase the contributions of rabbit income to the household income, Therefore, it is recommended that credit-lending organizations, such as commercial banks and microfinance institutions, should provide rabbit farmers with reasonable and accessible credit in order to strengthen their capacity to meet expenditures related to the production and marketing of rabbits. Contacts with extension agents was also found to positively affect the contributions of rabbit income to the households income, We urge the promotion of training initiatives in all fields of rabbit farming by deployment of more extension agents.
5. Rabbit producers should also receive training from animal health professionals on how to handle common rabbit infections because there aren't enough veterinarians to go around. In doing so, the farmers will be able to address the widespread illnesses.

In the short and long terms, all of the aforementioned suggestions will improve the livelihood and well-being of rural farmers, including their household members.

Author contribution statement

MATTHEW DUROJAIYE AYENI: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

MATTHEW OLANIYI ADEWUMI: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

ADEIZA MUHAMMAD BELLO; KUDIRAT FUNMILAYO ADI: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

ADEOLA ADENIKE OSUNGADE: Performed the experiments; Contributed reagents, materials, analysis tools or data.

Data availability statement

Data associated with this study has been deposited at <https://doi.org/10.6084/m9.figshare.21371265>.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2023.e18568>.

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