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Factors predisposing rabbits to rabbit hemorrhagic disease (RHD) in Oyo State, Nigeria

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Target Audience: *Rabbit farmers, academia, policy makers, livestock production practitioners and general public*

Abstract

Rabbit Hemorrhagic Disease (RHD) is a highly infectious fatal viral disease of economic importance which was implicated in recent outbreak among rabbits in South-West Nigeria. This study was carried out to examine factors associated with RHD outbreak on rabbit farms in Oyo state in order to make recommendations for control and prevention of future outbreaks. Physical visits were not made to rabbit farms in order to limit the horizontal spread of the disease. A meeting was organized to interact with fifty-one rabbit farmers who also filled out structured questionnaire to give information such as basic management practices and biosecurity measures on their farms. Descriptive statistics such as percentages and discrete choice model were used for data analysis. Most (70.59%) of the farmers are small-scale rabbit farmers whose farms are multi-livestock oriented. RHD was experienced by 37.25% of the farmers. Necropsy findings include hemorrhagic tracheitis, sero-mucoid nasal discharge, congestion of lungs and liver parenchyma. The use of commercial feed and thoroughfares to visitors were factors which significantly (at 5% level) increased the probability of RHD occurrence by 0.62 and 0.91 respectively. Strict biosecurity protocols must be observed on rabbit farms to control and prevent RHD.

Key words: *Rabbit Hemorrhagic Disease; RHDV2; necropsy; biosecurity*

Description of problem

Rabbit Hemorrhagic Disease (RHD) also known as Viral Hemorrhagic Disease (VHD), has been reported in over 40 countries in Africa, America, Asia, Europe and Oceania and is endemic in most parts of the world (1). Rabbit Hemorrhagic Disease Virus (RHDV) of the *Caliciviridae* family and of the Genus *Lagovirus*, consists of pathogenic viruses and non-pathogenic viruses which are related but genetically divergent. Three strains of this virus have been identified and they are RHDV, RHDVa and RHDV2 (Rabbit Hemorrhagic Disease Virus serotype 2). RHDV2 is believed to have emerged sometime around 2010 in Europe and has since then spread to many countries.

Outbreaks of RHD have been experienced in some West African countries since late 1980s (2), but the first outbreak in Nigeria was reported in June 2020 in Ilorin, Kwara state among rabbits raised on commercially produced feed under intensive management (3). A confirmatory diagnosis of RHD in Nigeria was carried out by (3) who ascertained the causal virus to be RHDV2. This highly infectious fatal viral disease of economic importance has also been implicated in recent outbreak among rabbits in South Western region of Nigeria. Although RHD has been diagnosed and

confirmed in Kwara state, only tentative diagnosis have been made in Oyo state as at the time of this study, based on clinical signs observed across farms and information obtained from farmers through interview schedules and through post mortem examinations.

RHD is a novel disease in Nigeria, thus, this study was carried out to examine factors associated with RHD outbreak on rabbit farms in Oyo state in order to make necessary recommendations for control and the prevention of future outbreaks.

Materials and Methods

In order to limit the horizontal spread of the disease, researchers involved in this study did not include the visit to rabbit farms in the schedule of activities for the methodology of the research. However, initial information was gathered from conversations with farmers through phone calls. A meeting was thereafter organized to interact with the rabbit farmers in Oyo state where they also filled out structured questionnaire to give information on basic management practices, biosecurity measures in place and other information related to their rabbits. A total of fifty-one rabbit farmers were involved in this study. There were two major groups of farmers - those who experienced the outbreak of RHD on their farms and those who did not experience the disease. This formed the basis for the use of the discrete choice model whose fundamental pillar of analysis is the model for binary choice (4) for analysis of data in addition to descriptive statistics such as percentages.

Table 1: Socio-demographic characteristics of rabbit farmers

Characteristic	Frequency	%
Sex		
Male	40	78.43
Female	11	21.57
Age (years)		
18-35	22	43.14
36-54	21	41.18
55-69	8	15.68
Mean age = 40.61years (SD =14.14)		
Education		
None	1	1.96
Secondary	2	3.92
Tertiary	48	94.12
Marital status		
Single	18	35.29
Married	33	64.71

Results and Discussion

Socio-demographic characteristics of rabbit farmers: Most (78.43%) of the rabbit farmers were males with an average age of 40.61 (± 14.14) years with majority (84.32%) being within the age range of 18-54 years (Table 1). Literacy level among the farmers can be regarded as high since more than ninety per cent (94.12%) of them had tertiary education.

Features of rabbit farms and the experience of RHD: About ten per cent

(11.76%) of the rabbit farmers kept only rabbits while others (88.24%) raised some other livestock in addition to the rabbits (Figure 1). These other livestock include poultry, fish, swine, sheep and goats. More than fifty per cent (56.86%) of the farmers had poultry while only 1.96% had cane-rat in addition to rabbits. Other animals raised by farmers include small ruminants (sheep and goats), swine, fish and snails.

With regards to the population of rabbits on the farms, only 7.84% of the farmers had more than fifty rabbits on their farms. Most (70.59%) of them had less than twenty rabbits and can therefore be regarded as small scale rabbit farmers. It is interesting to note that none of the farms with rabbit population of more than fifty experienced RHD as at the time of this study. Thirty-six per cent (36.36%) of those with 20-50 rabbit population experienced the disease while 45.45% of those with less than 20 rabbits experienced the outbreak.

Rabbit farm ownership was mainly personal with initial stock obtained from several sources such as the open market and farmer-friends (Table 2). Relating the RHD outbreak to source of initial rabbit stock, 42.86% of stock from the market, 33.33% bought from farmer-friends and government institutions as well as 100% of those received as gifts experienced RHD. Furthermore, the importance of education in any enterprise cannot be over-emphasized.

Table 2: Features of rabbit farms

Features	Number	%
Source of initial stock		
Gift	4	7.84
Market	21	41.18
Another country	2	3.92
Farmer-friend, government institution	24	47.06
Rabbit farm ownership		
Personal	42	82.35
Family	4	7.84
Group	1	1.96
Contract farming	1	1.96
Government	3	5.88
Type of housing		
Hutch	45	88.24
Floor and hutch	1	1.96
Floor	5	9.80
Rabbit population		
Below 20	36	70.59
20 -50	11	21.57
51 – 70	2	3.92
71 – 100	1	1.96
Above 100	1	1.96

Some (56.86%) of the farmers had attended previous training sessions on rabbit production and management. The remaining 43.14% had not attended any form of training related to rabbit production and management. Comparing the incidence of RHD on farms with trained and non-trained farmers, more than half (68.97%) of the trained farmers had no incidence of RHD among their rabbits (Figure 1). RHD

incidence was higher among non-trained farmers with incidence among 45.45% against 31.03% of trained farmers.

The most widely used source of feed is the commercial feed which was used by 64.71% of the farmers for feeding their rabbits. Only 17.65% reported personally compounding their own feed. Other sources of feed are household wastes and green leaves from gardens and nearby bushes. However, it is important to note that combinations of two or more sources of feed were used by some of the farmers.

Table 3: Signs observed on sick rabbits

	Signs	% of farms
1	Violent shaking	10.53
2	Mucus-like discharge from nose	5.26
3	Bloody/brownish diarrhea	15.79
4	Coughing	5.26
5	Bloat	5.26
6	Still-birth	10.53
7	1 and 2	5.26
8	2 and 3	5.26
9	Discharge of blood from nose	0.00
10	1 and 9	5.26
11	1,2 and 5	5.26
12	3 and 9	5.26
13	1, 3,4 and 9	5.26
14	1,2,3,4 and 5	5.26
15	No sign but sudden death	10.53

Clinical signs of RHD: Common clinical signs that have been associated with RHD include fever, anorexia, apathy, congestion of the palpebral conjunctiva, epistaxis, lacrimation, ocular hemorrhages, neurologic symptoms (ataxia, opisthotonos, paralysis), respiratory signs (cyanosis, dyspnea, tracheitis) and foamy and bloody nasal discharge (5). In most situations, not all of these clinical signs are mutually exclusive. While some rabbits show one or two of these clinical signs, others just drop dead showing very little or no signs.

RHD was experienced by thirty-seven per cent (37.25%) of the farmers on their rabbit farms (Ibadan, Ogbomoso, Omi-Adio, Akinyele, Ilora and Oyo towns) all between September 2020 and February 2021. At the time of this study, only 56.86% of the farmers were aware of RHD. The disease affected all categories of rabbits, that is, male and female of weaners, growers and adults. This disease is novel in Nigeria and the clinical signs vary from one farm location to another. In majority of farms that have recorded mortality, the clinical signs recorded are acute while some others do not show any clinical signs. The signs of disease in the rabbits as observed by the farmers include discharges from the nose, violent shaking of the body, bloody/ brownish diarrhea and cough. In some cases, there were no obvious signs until death. Table 3 presents the signs observed by farmers on rabbits that were infected. A total of 36.84% of farmers indicated that their rabbits experienced multiple clinical signs before death. On the whole, a total of 15.78% of farmers had rabbits with bloody discharge from nose; 36.83% had bloody/brownish

diarrhea; 26.3% had mucus-like discharge from nose and 36.83% displayed neurological signs. None of the farmers carried out a veterinary diagnosis of the disease on their rabbits and none of them suspected RHD. However, disease cases were reported as incidences of suspected cases such as rabbit ebola, pneumonia, helminthosis and coccidiosis. Mortality was not up to a hundred per cent in any of the farmers' rabbit farms. It is noted however that the signs observed by the farmers are those associated with RHD. Interventions employed by farmers were culling and disinfection/fumigation of hutches.

Table 4: Necropsy findings in rabbits from RHD outbreak in Oyo state

	Score (maximum=5)
Congestion of liver parenchyma	2
Cooked and friable liver	3
Pericardial hemorrhage	1
Seromucoid nasal discharge	5
Patches of congestion on the lungs	3
Highly pale lungs with patches of necrosis	2
Petechial hemorrhage on the cecal and colon serosa	2
Serosanguineous fluid in the peritoneal cavity	
Hemorrhagic tracheitis	
Distended urinary bladder with turbid yellowish urine	

1 = mild, 2 = moderate, 3 = severe, 5 = very severe

Table 5: Health management practices

	frequency	%
Farmers' awareness about biosecurity		
Positive	45	88.24
Negative	6	11.76
Periodic pen disinfection		
Yes	43	84.31
No	8	15.69
Awareness about RHD		
Positive	29	56.86
Negative	22	43.14
Disease outbreak experience		
Positive	19	37.25
Negative	32	62.75
Disposal of mortality		
Bury	29	56.86
Burn	7	13.73
Throw in river	1	1.96
Throw in bush	2	3.92
Cut and cook	1	1.96
No mortality yet	11	21.57

Necropsy findings: Although several body tissues may be affected, it has been noted that the primary target tissues of RHDV are the liver, lungs and spleen. Necropsy results by (5) revealed the presence of acute hepatitis, hemorrhages and congestions in

the heart, lungs and kidneys resulting from a massive Disseminated Intravascular Coagulation (DIC) which usually is the cause of death. Reported findings of necropsy on rabbits from the Kwara state RHD outbreak by (3) include epistaxis, haemorrhagic tracheae, oedematous and congested lungs, enlarged and friable liver, thickened heart ventricles, haemorrhages in small intestine mucosa, distended urinary bladders which contained yellow turbid urine and enlarged kidneys. For this study, a necropsy procedure was carried out for a sample of rabbits and results are as shown in Table 4.

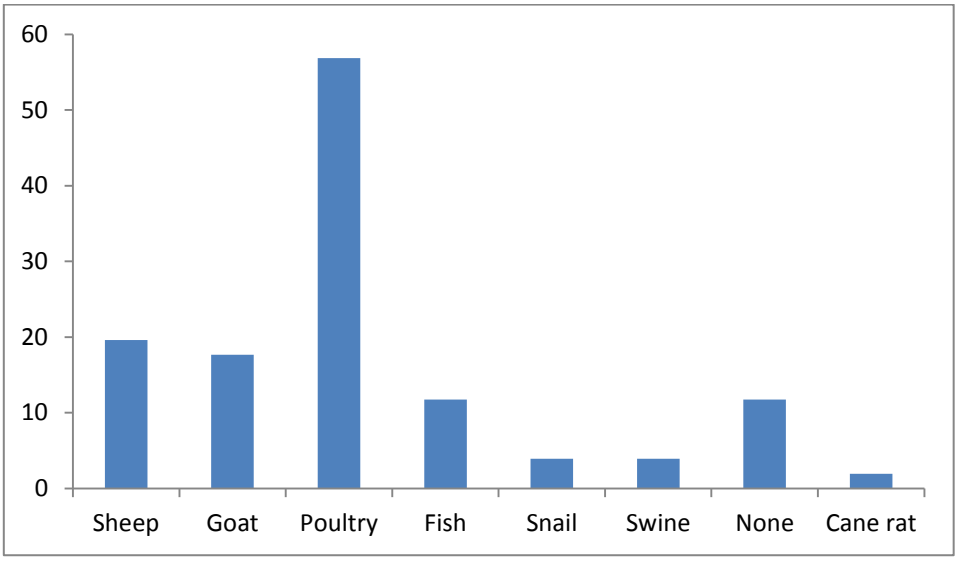


Figure 1: Animals reared in addition to rabbits

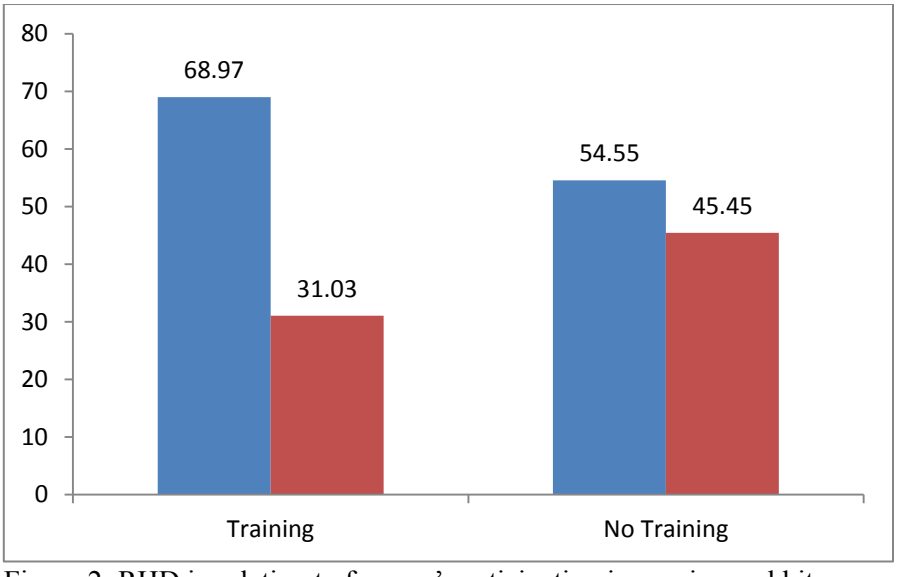
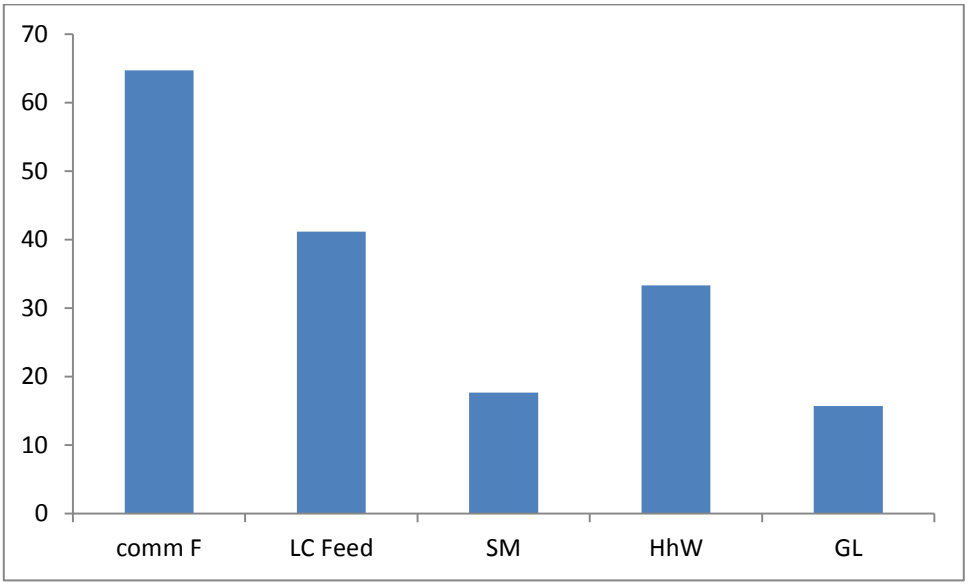


Figure 2: RHD in relation to farmers' participation in previous rabbit management training

Health management practices: According to (6), RHD particularly RHDV2 can spread through direct contact or exposure to infected rabbit's excretions or blood, contaminated food, water and other materials such as people's shoes and clothing. Good biosecurity measures must be put in place to protect rabbits from disease infection. Table 5 presents the health management practices observed by the rabbit farmers.

Disease outbreak occurred in 39.53% of farms with scheduled disinfection of hutches/pens. Most (84.31%) of the farmers carried out routine disinfection of rabbit hutches/pens. This was carried out at least once a week by 34.88% of the farmers and monthly by 62.79%. More than half (60.47%) of farms with routine disinfection did not experience RHD outbreak. However, only 37.5 % of farms with no routine disinfection had the outbreak.

The mode of carcass disposal is very crucial to the spread of disease. For instance, carcasses of RHDV-infected rabbits exposed to environmental conditions have been found to contain viable viral particles for up to three months (7). Carcasses were buried by 56.86% of the farmers and burnt by 13.73%. However, carcasses were not properly disposed by 7.84% of the farmers who threw in the bush, river or cooked for consumption.



Comm F = commercial feed; LC Feed = locally compounded feed; SM= self-made feed; HhW= household waste; GL= green leaves.
Figure 3: Sources of rabbit feeds

Factors predisposing rabbits to RHD: Based on information obtained from farmers, some factors were tested empirically using the binary choice model in order to determine those that predispose rabbits to RHD and significantly do so. This will help to guide farmers in taking necessary precautions to prevent future outbreak of the disease.

The binary choice model helps to investigate and explain the correlation between y and the x_i elements.

Table 6: Results of probit regression

Explanatory variables (x_i)	coefficient	z	P>(z)
Sex of farmer	-0.1115	-0.21	0.835
Farmer's training	-0.4099	-0.89	0.375
Farm ownership	-0.1671	-0.31	0.758
Commercial feed	0.6183	2.37*	0.018
Distance to next farm	0.0974	0.19	0.846
Visitors	0.9071	2.00*	0.045
Frequency of disinfection	0.4966	0.96	0.335
Constant	0.4402	0.45	0.652
LR Chi2(7) = 14.31			
Prob>Chi2 = 0.0460			

*Significant at 5% level

The study estimates the probability that RHD will occur on a rabbit farm,
that is, Pr ($y_i = 1| x_i$)
Assume latent unobserved variable

$$y^*_i = x'_i\beta - \varepsilon_i$$

$x'_i\beta$ is explained by observable explanatory variable x_i
ε_i is stochastic error term that is unobservable to researcher but observable to respondent i
$y^*_i = x'_i\beta - \varepsilon_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \text{------} \beta_n x_n - \varepsilon_i$
y^*_i is unobservable to researcher but determines observable dependent variable y_i by assuming

$$y_i = 1 \text{ if } y^*_i > 0$$

and $y_i = 0$ if $y^*_i \leq 0$
Following (4),
$\Pr(y_i = 1/x_i) = F(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \text{------} \beta_n x_n)$

$$\Pr(y_i = 1/x_i) = F(x\beta)$$

Where F is a function which takes on value strictly between zero and one. That is,
$0 < F(z) < 1$ for all real numbers z.
$0 < F(z) < 1$ can be referred to as an index model since $\Pr(y_i = 1/x_i)$ is a function of the vector x only through the index

$$x\beta = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \text{------} \beta_n x_n$$

which is simply a scalar.
$0 < F(x\beta) < 1$ ensures that the estimated response probabilities stay strictly between zero and one. F is a cumulative density function which normally increases monotonically in the index z, that is, $x\beta$ with

$\Pr(y_i = 1/x_i) \rightarrow 1$ as $x\beta \rightarrow \infty$
$\Pr(y_i = 1/x_i) \rightarrow 0$ as $x\beta \rightarrow -\infty$
In the probit model, F is the standard normal cumulative density function expressed as an integral

$$F(x\beta) = \phi(x\beta) \equiv \int_{-\infty}^{x\beta} \phi(v)\, dv$$

F ensures that the probability of 'success' which in this case is 'occurrence of RHD' is strictly between zero and one for all values of the parameters and the explanatory variables.
Thus,
Y is occurrence of RHD on rabbit farm
Y = 1 (If RHD was experienced on the farm); Y = 0 (If otherwise)
Results of the probit regression are presented on Table 6. It is interesting to note that farmers' training on rabbit production and management had no significant effect on the occurrence of RHD on their farms. Also the distance between rabbit farms had no significant effect. In addition, the frequency of hutch and pen disinfection had no significant effect. This result does not however do away with the importance of these factors (disinfection, training and

distance between farms). Under good management system, there must be scheduled routine disinfection of hutches and pens. The results of this study only underscore the need for a holistic biosecurity package. Two factors which had significant effect on the occurrence of RHD on farms in the study area are the use of commercial feeds and thorough fare of visitors on the farm.

The transaction of business by visitors on the farm site increases the probability of disease outbreak by 0.91 or 91%. This is a serious concern as 88.24% of the farms have other livestock which attract visitors/customers who transact business on-site. The reason is quite obvious as disease pathogens can be transferred from one farm/location to another via shoes, clothing and other materials. Hands of visitors also can carry pathogens which are transferred when they touch healthy livestock.

Although commercial feeds are a good source of feed for rabbits, they can be medium through which disease pathogens are transferred as they are transported from one location to another. More than half (64.71%) of the farmers fed their rabbits with commercial feeds wholly or to supplement feeds from other sources such as household wastes. Results indicate that the use of commercial feeds increases the probability of having RHD outbreak by 0.62 or 62%. This is a pointer to the need for quality control of commercial feeds right from production, through transportation/ distribution to consumption.

Conclusion and Applications

1. Over forty per cent (43.15%) of the farmers had not heard of RHD hence need for adequate publicity on this fatal rabbit disease.
2. Farmers should put necessary and strict bio-security measures in place on their farms, especially where visitors have to transact business. This is very crucial as 88.24% of the farms are multi-livestock farms where other animals are reared in addition to rabbits and visitors transact business.
3. The use of commercial feed was found to increase the probability of RHD outbreak on a farm. Feed millers must therefore take appropriate precautions to avoid spread of disease through their products while regulatory agencies must ensure that commercial feed millers follow the prescribed protocol for production and distribution of their products.
4. The disease can rapidly spread from one infected rabbit to others on the farm, its vicinity and beyond. Thus, biosecurity measures on all rabbit farms for the prevention and control of RHD are crucial in order to limit spread and ensure prevention of the disease.
5. None of the farmers in this study did veterinary diagnosis when signs of disease (clinical signs of unsuspected RHD) were observed among their rabbit flock. Farmers must consult veterinary personnel for immediate diagnosis of disease in the case of any observed signs of disease among their livestock flock.

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