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Assessment of Factors Influencing Level of Adoption of National Veterinary Research Institute (NVRI) Vaccine among Cattle Farmers in North Central Nigeria

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Abstract
Millions of Nigerians rely on their livelihood from livestock enterprises, a significant part of the country's economy. Studies have shown that animal disease is the most prominent among the numerous challenges animal production faces due to the lack of vaccination against common diseases in north-central Nigeria. This paper aims to evaluate cattle farmers' perceptions and the factors that affect how widely they use the NVRI vaccination. In Northwest Nigeria. Combined support from the livestock sector of ADPs in each state, animal health workers and NVRI staff, a total of 300 cattle beef producers were randomly selected. The permission of potential participants was obtained to circumvent coercion and forms of pressure on them when deciding to participate. Using analytical tools including descriptive statistics, Logit, and Tobit regression models. Primary data were gathered and analyzed. The perception of cattle producers shows that NVRI vaccines were readily available (3.1) to cattle farmers, cheaper than imported vaccines (3.5), protect against disease (3.4), and are economical and inexpensive for small-scale livestock farmers (3.7) compared to imported. Using Logit and and Tobit regression models, the coefficients of variables that contribute to the decision to adopt the NVRI vaccine: herd size (0.097); access to extension agent (5.981); and income (0.004) differ statistically and significantly by structure, magnitude, and probability level from factors that influence the intensity of adoption of NVRI vaccine such as herd size (0.991); access to extension (0.237); income (2.340) and location (0.868) by cattle farmers. Since extension is a factor for intensity for adoption, there is a necessity for supplementary extension aid in terms of staff capacity building and mobility to improve farmer coverage staff.
Keywords: extension, improved livelihood, farmers' perception, and vaccine

*I*ntroduction

From being utilized as a financial system in Africa to being a holy symbol in India, livestock production is culturally entrenched into the social fabric of society globally (Eckard *et al.*, 2012). The socioeconomic development of Nigeria depends on livestock husbandry, a crucial component of Nigerian society and agriculture., around 13 million households keep farm animals in Nigeria (Enahoro *et al.,* 2021). Besides the creation of employment and income generation, livestock production also supplements the income of fringe farmers and landless labourers in meeting their nutritional requirements as well as a store of wealth and provides a form of social security (Poudel *et al.,* 2020). In addition, livestock production provides raw materials for industries and foreign exchange earnings for the government (Kemi, 2016). Furthermore, livestock, especially cattle production, provides animal traction to land areas under production and also for about 50% of the world's farmers (Yitbarek, 2019).

According to estimates, there are over 18.2 million heads of cattle in Nigeria. Most of these cattle are raised in large herds by semi-sedentary and transhuman pastoralists, 82 per cent are raised in extensive systems, 17 per cent in semi-intensive systems, and only a small % are raised in intensive systems (FAO 2019; FAOSTAT, 2019). In particular, the northern region of the country has 90 per cent more cattle than the southern part of the country, and it has 70 per cent more sheep and goats than the southern part, which may be a result of the northern region's longer dry season, lighter sandier soils, and shorter rainfall duration (Lawal, 2012).

The National Veterinary Research Institute (NVRI) was ounded in 1924 to eradicate Rinderpest epidemics,

which had decimated the late 19th and early 20th century cow herd in Nigeria. The NVRI's current mandate has grown to include a wide variety of initiatives to enhance animal health and production in the country and elsewhere. NVRI currently includes 23 outpost laboratories dispersed throughout the country and the Central Diagnostic Laboratory (CDL) at Vom. The NVRI also serves as the West and Central African Regional Laboratory of the FAO for Avian Influenza and Other Transboundary Animal Diseases. The institute has created and manufactured nineteen vaccines for a variety of bacterial and viral infections.

The NVRI offers vaccinations to the general public, including state and federal agencies and the business sector. Both state and federal governments purchase vaccines for serious transboundary diseases like PPR, CBPP, and rabies to support mass veterinary immunization programs. In contrast, various vaccinations, like the vaccinations for NDV and FMDV are primarily traded to nearby farmers, either directly or via agri-product traders. Nigeria's economy relies heavily on the cattle and beef industries to support the livelihoods of millions of people. However, an examination of the import, export, and production trends for cattle from 2005 to 2019 revealed that domestic production cannot keep up with the nation's rising demand. Also, studies (Aboah *et al*., 2021, FAO, 2018 & 2019, Byran, 2020, Kemi 2016, Ogah *et al.,* 2014) have shown that animal disease is the most prominent among numerous challenges that Nigerian animal production faces this may be caused by the fact that people in northern Nigeria are not immunized against prevalent diseases.

The NVRI Vom is located in Plateau State, North-central and has been producing different livestock vaccines for more than 80 years for the public that is, state government, federal governments and, private sectors. How has the production of these vaccines affected the livestock farmer and livestock production in general? In light of the aforementioned, the goal of this study is to evaluate the perceptions of and the variables affecting the degree of adoption of the NVRI vaccination by cattle farmers in the north-central region. The study could add to the literature and the database of the institute on the perception and adoption of NVRI vaccines among cattle farmers in selected states of north-central Nigeria. Furthermore, the data generated from such analyses will allow policymakers, implementing partners, industries and researchers to make decisions based on the best, and most contextually relevant, available evidence that will benefit the country.

Methodology

North Central Nigeria, sometimes denoted as the Middle Belt comprises Benue, Kogi, Kwara, Nasarawa, Niger, Plateau States, and the Federal Capital Territory (FCT). The study was conducted in three (3) north-central states of Nigeria- Kogi, Nasarawa, and Plateau between June and December 2021. NVRI, Vom is one of the Nigerian Agricultural Institute's duties include developing and producing animal vaccines, sera, and biologicals to suit local and regional demand, as well as performing investigation of all facets of animal illnesses, care, and management. NVRI currently produces nineteen (19) vaccines to protect against various bacterial and viral infections and pathogens. These include vaccinations for Contagious Bovine Pleuropneumonia (CBPP), rabies, anthrax, Infectious Bursal Disease (Gumboro), Peste des Petits Ruminants (PPR), Sheep and Goat Pox (SPP and GTP), Lumpy Skin Disease (LSD) and others (NVRI Annual Report, 2019). In this study, a multistage sampling approach was used. Based on accessibility and relevance to the research, the first stage entails the purposeful selection of three (3) states from the list among the six (6) states in the region's north-central. In total six (6) Local Government Areas (LGAs) are chosen at random from each of the three states where NVRI vaccines are marketed and used by livestock farmers in the second stage. combined support from the livestock sector assistance of livestock section of ADPs in each state, animal health workers and NVRI staff, a total of 300 cattle beef farmers was used as the sample size (Table 1). Primary data were collected, including the farmers' perception of the use of the NVRI vaccine with the assistance of trained enumerators under the supervision of the researcher. This was achieved with the aid of a questionnaire and secondary data, obtained mainly from publications and annual reports of NVRI. A pre-test using 10% randomly selected respondents was carried out in February 2021 to determine the extent to which the questions in the research instrument were comprehended. A validity test was carried out to assess if the research instrument measured what it was supposed to measure. Extensionists, agricultural economists and veterinary workers were used to validate the research instrument for correctness and perfection.

Five-point Likert Scale was used to determine the awareness of cattle farmers using NVRI. Based on Rogers's (2003) theory of diffusion, the level of adoption of the NVRI vaccine was classified to a continuum scale of very high vaccine adopters (VHva), high adopters (Hva), moderate adopters (MDva), Least adopters (LEva) and Non-adopters (NOva) with favourable comments given a weight of 5, 4, 3, 2, and 1, respectively, (level of adopting) correspondingly, and the opposite for a negative statement (non-adopter). The following weighted mean was calculated for each indicator based on Likert (1932), a technique for the measurement of attitudes, adopted and modified by Bagheri *et al.* (2008), Bagheri, (2010), Gido *et al.* (2013), Oladimeji *et al.* (2016), and Oladimeji *et al.* (2017). This is expressed as:

$$WM = (fVHva * 5) + (fHGva * 4) + (fMDva * 3) + (fLEva * 2) + (fNOva * 1) / n \ldots (1)$$

Where: WM = weighted mean; F = frequency; Values 5, 4,3,2,1.

Similar studies of the adoption of agricultural

technologies in different countries include Bagheri *et al.* (2008), Bagheri, (2010), Gido *et al.* (2013), Oladimeji *et al.* (2016), and Oladimeji *et al.* (2017), and Inferences were drawn as follows: 1.00-1.49 = Non-adopters (NOva), 1.50-2.49 = Late adopters (LEva); 2.50-3.49 = moderate adopter (MDva); 3.50-4.49 = high adopters (HGva) and 4.50-5.00 = very high adopters (VHva);.

A Logit regression model was employed to estimate the variables influencing the adoption of the NVRI vaccine while the the extent of the adoption of the NVRI vaccine was determined using the Tobit regression model. The empirical logistic regression model is stated thus:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_{11} X_{11} + e_i \quad \ldots..(2)$$

Where: Y_i = Use of NVRI Vaccine (Yes/No).

The Tobit model was utilized to evaluate the extent of the adoption of the NVRI vaccine.

The model is explicitly stated as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_{11} X_{11} + e_i \quad \ldots.(3)$$

Y_i defiNES the level of adoption of a vaccine. The independent variables for the double Hurdle model (Logit and Tobit regression models) were X_1 = age of the cattle farmers (years), X_2 = gender (dummy, male =1 and 0 otherwise), X_3 = marital status (married, single widowed or divorced), X_4= experience (years), X_5 = years of education (years), X_6= household size (number), X_7 = membership of cooperatives (years of membership), X_8= extension contact (number), X_9 = access to credit (Naira), X_{10}= herd size (Number), and X_{11} = income (Naira).

The analysis was achieved using the STATA statistical package.

Results and Discussion

Perception of Cattle Farmers on Adoption of NVRI Vaccine

five-point Likert scale was used to determine The perception of cattle farmers using NVRI and the results are presented in Table 2. Results show that the perception that the NVRI vaccine is readily available has an average weight of (3.1). This indicates that there are reliable and secure vaccines, they are made in huge quantities, and they are available for purchase. This is consistent with the finding of Brake *et al.* (2020), who noted the requirement for highly efficient and secure veterinary vaccines (RG-3 and RG-4) against the wide range of epizootic and enzootic TADs and zoonotic diseases currently affecting livestock populations in sub-Saharan Africa (9SSA), Asia, and Southeastern Asia. NVRI vaccines are cheaper than other vaccines and have an average weight of (3.5), considered highly rated. This implies that the NVRI vaccines are affordable to livestock farmers which might facilitate vaccine uptake by decreasing adoption barriers. This is consonant with the finding of the Campbell *et al.* (2018) study that, to increase vaccine coverage, attention should be paid to the connection between vaccine adoption and cost. The perception that the NVRI vaccine protects against disease and is accessible was highly rated with an average weight of (3.4). This implies that the NVRI vaccine can activate the protective immunity of clinically relevant strains to livestock more so that the Institute (NVRI Vom) uses local strains of disease pathogens for the production of the vaccines and it also has increasing affluence and food security is a possibility. This is in line with the studies of Hopker *et al.* (2021), and Truong *et al.* (2018), that successful livestock vaccination could increase rural poor people's well-being and access to food in low-income and middle-income nations and farmers' perception of the effectiveness of vaccination strongly affects their willingness to implement it. The packaging dosage of NVRI vaccines is economical (3.4) and packaged in smaller dosages which is economical for small-scale farmers (3.7) was highly rated by the livestock farmers. This implies that the NVRI vaccine is in packaging with a few dosages per package which are desirable to small-scale farmers, They reduce waste and are more affordable. It also prevents community sharing which could be a barrier to vaccine adoption. This is consistent with the research of Campbell *et al.* (2018), which states the reason in favour of a causal link between flock size and vaccination is the existence of vaccine access restrictions specific to families with small flocks.

Factors that influence the decision to adopt the NVRI vaccine by cattle farmers

The results in Table 3 depict the variable that highlights what goes into choosing to adopt the NVRI vaccine for cattle farmers. The generalized log-likelihood functions (LLF) from the Maximum Likelihood Estimate (MLE) were -53.875. The LLF suggests that there is a statistically significant relationship between the explanatory variables in the model and the coefficient of factors influencing the choice to use the NVRI vaccination (dependent variable) collectively contribute significantly to the Logit results. Thus, the functional form of Logit regression analysis used in this estimation adequately represents the data. The LRchi^2(12) value of 168.87 implies that the model has a good fit while Prob > chi^2 implies significance at a 1% probability level. The findings of Hana's (2019), can be compared to the instance of Basona Warena Woreda, Amhara region, Ethiopia, regarding the adoption of dairy technology and its implications on household food security. At a 1% probability level, the herd size coefficient is positive (0.097) and statistically significant. Accordingly, adoption of the NVRI vaccination is predicted to rise by 0.097 units when herd size rises. This is consistent with Bayan and Dutta's (2017), study on the adoption of crossbred cattle and its effects on increasing employment in small-scale dairy farming in rural Assam, where some key factors like herd size, membership in the dairy cooperative society (DCS), and being a recipient of government dairy development programs, all had a significant and positive influence on the adoption of high-yielding crossbred cattle. According to the coefficient of access to extension

agents, which is positive and statistically significant at the 1% level of probability, increasing access to extension agents will result in a 5.981 unit increase in the usage of NVRI vaccination. This further implies that access to extension agents will increase awareness of the use of vaccines in disease prevention and boost livestock output. Hana (2019), also discovers that farm households tend to adopt new dairy innovations more frequently if there has access to extension contacts and frequent visits from developmental agents. At a 1% probability level, the income coefficient is statistically significant and positive (0.004). This suggests that a unit rise in the livestock farmer's income will result in a 0.037e-05 increase in his ability to buy vaccination drugs to provide to his animals. It also means that the adoption of the NVRI vaccination will rise when the farmer's income rises by a unit. This is consistent with the findings of Oladimeji *et al.* (2016), who found that among artisanal fisherfolk in Kwara state, Nigeria, there is a statistically significant difference in the average annual fish revenue between adopters and non-adopters of fishing tools and powered canoes.

Factors that influence the intensity of adoption of the NVRI vaccine by cattle farmers

According to Table 4 findings, the generalized log-likelihood function (LLF) is 554.94, indicating that there is a statistically significant relationship between the likelihood that socioeconomic variables will affect how widely the NVRI vaccine is used (or adopted) and the explanatory variables included in the model will collectively explain how these factors will affect how intensely the NVRI vaccine is used. Tobit regression analysis' functional form, which is employed in this estimation, is a suitable representation of the data. According to the LR chi^2 (12) value of 774.79, the model has an excellent fit, and Prob > Chi^2 is statistically significant at the 1% level. This outcome is comparable to that of the Yitbarek (2019), study, which identified an increase, where wealth growth was the main factor contributing to the rise in demand for animal products. The Tobit regression result depicts that the coefficient of herd size (p>0.00), income (p>0.00) access to extension agent, (p>0.05) nearness to the NVRI, vom (p>0.05) influence the intensity of adoption of NVRI vaccine. The coefficients were positive and statistically significant at 1% and 5% probability levels, respectively. The income implies that the extent of adoption of the NVRI vaccine increases when the farmer's income increases. This is in line with the study carried out by Hana (2019), which revealed that better dairy technology can be adopted by households with higher incomes. According to the study's findings, households that adopted dairy technology had improved milk output, greater food security, and more varied diets. Herd size (p>0.00) suggests that as the herd size rises, the adoption of the vaccination also rises, which is in line with Dhraief *et al.* (2018), hypothesis that larger farmers in Tunisia who have greater herd sizes of cattle would be more likely to use IT. Income (p>0.00) suggests that when income rises, adoption rates rise as well, resulting in healthier cattle and an increase in stock. According to Mandleni *et al.* (2018), farmers who retained fewer cattle in a prior year were able to generate enough revenue from livestock sales to increase or rebuild their stock in the subsequent year or years after. Access to extension agents, (p>0.05), suggests that increasing contact with extension agents leads to an increase in vaccine adoption. According to Musa *et al.* (2019), extension services' contribution to the evolution of agricultural practices has a greater influence on influencing the acceptance of contemporary technology. According to Chuchird *et al.* (2017), due to its simplicity of implementation and proximity to water sources, the adoption of pump irrigation schemes was widespread in the research area. Nearness to the NVRI (p>0.05) suggests that states closer to the NVRI Vom have access to the vaccine than those far away.

Conclusion

Farmers perceived that NVRI vaccines are available, offer disease protection, and are reasonably priced for cattle farmers. According to the Logit and Tobit results, herd size, access to extension agents, and income were found to be the major variables that influence the use and intensity of adoption of the NVRI vaccination. The development of additional access points closer to the cattle farmers and the maintenance of distribution mechanisms that will create a sustainable supply chain via rural retailers, farmers associations, local authorized vaccine providers, and other community structures are necessary because the NVRI vaccine has a positive and significant impact on the income of cattle farmers in north-central. Additional extension support is required for staff mobility and capacity building to increase farmer coverage.

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Table 1: Distribution of sample frame of cattle beef farmers and sample size

States	LGAs	Sample frame	Sample size (100%)
Kogi	Lokoja	70	70
	Kabba	50	50
Nasarawa	Wamba	40	40
	Awe	30	30
Plateau	Barkin-Ladi	75	75
	Shendam	35	35
Total	6	300	300

Source: Reconnaissance survey, 2021

Table 2: Perception of livestock farmers about NVRI vaccine

NVRI vaccines	SD	D	N	A	SA	WS	Mean
are available	79	54	2	13	91	734	3.1
are accessible	99	3	2	50	80	693	3.4
are cheaper than others	96	0	5	89	6	679	3.5
protects against diseases	98	2	10	109	5	751	3.4
packaging dosage is economical	87	6	38	86	1	746	3.4
are packaged in smaller doses	95	23	54	58	1	846	3.7
are expensive	60	50	56	80	70	898	2.8

Source: Field survey, (2022). Note: SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree, WS = Weighted sum

Table 3: Factors that influence the decision to adopt the NVRI vaccine by cattle farmers

_Variables	Coef.	Std. Err.	Z	P>z
Sex	-0.924	2.944	-0.310	0.754
Age	-0.013	0.037	-0.340	0.731
Marital status	2.019	1.627	1.240	0.215
Household size	0.089*	0.053	1.680	0.093
Education	-0.052	0.032	-1.620	0.105
Herd size	0.097***	0.027	-3.620	0.000
Experience	0.025	0.038	0.660	0.510
Cooperative membership	0.931	0.812	1.150	0.252
Access to credit	0.066	0.802	0.080	0.934
Access to extension agent	5.981***	1.143	5.230	0.000
Income	0.004***	0.001	3.450	0.001
Constant	-2.745	3.368	-0.810	0.415
Number of observations	292			
LR $chi^2(12)$	168.87			
Prob > chi^2	0.000***			
Pseudo R^2	0.6105			
Log-likelihood	-53.8752			

Source: Field survey 2022

Table 4: Factors that influence the intensity adoption of NVRI vaccine by cattle farmers

_Variables	Coef.	Std. Err.	Z	P>z
Age	-0.1459	0.1746	0.84	0.404
education	-0.1744	0.2541	0.69	0.439
herd size	0.9908***	0.1427	6.95	0.000
Experience	0.2738	0.1948	1.41	0.161
access to extension	0.236679**	0.113151	2.09	0.038
Income	2.340 ***	0.496	4.72	0.000
Plateau	0.86763**	0.45847	1.89	0.060
Nasarawa	0.72675	0.50268	1.45	0.150
Constant	-0.323633	0.142454	-2.27	0.024
LR $chi^2(8)$	774.79			
Prob > chi^2	0.000			
Pseudo R^2	-2.3122			
Log-likelihood	554.94039			

Source: Field survey 2022. Note: *** and ** indicate significance at 1% and 5% respectively