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Determinants of Technology Adoption in Livestock Production: Empirical Evidence from Sheep and Goat Farming in Kogi State, Nigeria

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Abstract

This study examined the determinants of technologies adoption among small scale sheep and goat farmers in Kogi state, Nigeria. The study employed the use of questionnaires to elicit information from respondents. Data collected for the study was obtained from two hundred and forty (240) respondents. Descriptive statistics and probit regression analysis were used to analyses the data. Results from the analysis showed a mean age of 48 years old for sheep farmers and 44 years old for goat farmers. The farmers acquired an average of 8 and 10 years of formal education with a mean of 12 and 11 years of farming experience, among sheep and goat farmers respectively. Most sheep farmers adopted supplementary feeding (26.7%), detection and isolation of sick animals (55%) while goat farmers adopted de-thickening (65%), supplementary feeding (45%), detection and isolation of sick animals (30%) respectively. Extension contacts and cooperative membership significantly influenced the adoption of improved sheep and goat production while herd size significantly influenced the adoption of improved goat production. It is recommended that extension service should be well funded considering its significance in determining adoption. Also, livestock farmers should be encouraged to form cooperative societies to ease their access to credit.

Keywords: Goat; Sheep; Determinant; Adoption; Technologies; Farmers

Introduction

Goat and sheep are the backbone of economy of small and landless farmers in Nigeria. It is insurance against crop failure and provides alternate source of livelihood to farmers all the year round. Small ruminants are used in ceremonial feasting and payment of social dues. In the religious circle, sheep are used by Muslims to fulfill religious obligation and goats as a source of protein [1]. During the period 2000-2013 there was an important increase in goats worldwide (33.79% or an average per year 2.6%). The world sheep population in the same period increased only 10.74% [2]. Among the continents, Asia constantly holds the first place having a contribution to the total goat population of 59.38% and an increase of goat number during the period 2000-2013 by 30.23%. Africa takes the second place with 35% contribution and increase, during the above period, 48.61%. In the Oceania is observed a spectacular increase in goat number (65.76%) during the same period. In the Americas the increase was only 3.13%, while in Europe and the E.U (28) was observed a relative decrease [2]. National Agricultural Sample Survey indicated that Nigeria was endowed with an estimated 19.5 million cattle, 72.5 million goats, 41.3 million sheep, 7.1 million pigs and 28,000 camels [3]. The contribution of Agricultural sector to Nigeria GDP were estimated as follows 2009 (26.75%), 2010 (23.89%), 2011 (22.23%), 2012 (21.86%), 2013 (20.76%), 2014 (19.99%), 2015 (20.63%), 2016 (20.98%), 2017 (20.85%), 2018 (21.20%) and 2019 (21.91%) goat and sheep inclusive respectively [3].

Agricultural innovation including animal husbandry has a successful introduction and exploitation of knowledge and technologies for social and economic benefits. The use of such knowledge and technologies brings about positive changes in how people make or do things, and ultimately improves their livelihoods [4]. Adoption of agricultural innovations is extremely important for the country's agriculture and consequently for the development of the people in the rural areas [5]. Farmers in general, used to adopt recommended practices in partial with wide technological gap especially in those complex practices in nature [6].

The supply and demand of improved technologies involves a multi-faceted interaction among different actors both in public and private sector with each playing significant roles to stimulate and trigger innovation development and adoption [7]. The acceptance of new technologies by farmers will contribute to the improvement of economical profitability in the short term and the living condition of people in long term. With the recognition of the farmer as part of the process, it may serve as an incentive to promote adoption of any technology. The adoption of agricultural technology depends on a range of personal, social, cultural, and economic factors, as well as on the characteristics of the innovation itself. The characteristics of the technology itself are also an important influence on farmers' technology adoption and usage decisions.

A set of innovative technologies have been introduced in the past in the livestock sector through international, national development projects and NGOs in modern nutritional methods and disease control. Despite the introduction of these innovations such as supplementary feeding, routine vaccination, housing of animals, mineral supplementation, cleaning of pen, detention and isolation of sick animals, disease control, hoof trimming, de-thickening of animals, extension agents; most of them are not adopted. Economic, socio-demographic, institutional, human specific (social) and technical factors (determinants of adoption of agricultural technologies) have influential roles in farmers' decisions related to the adoption of innovative and improved agricultural technologies [8-11].

Despite a sizeable population of National goat and sheep herd, it is still not sufficient to meet the requirement of the nation. This is primarily due to the subsistence nature of goat and sheep farming in the country. The main reasons for the stagnation of the goat enterprise are unscientific management practices, improper breeding, lack of nutrition and problems related to health and marketing management [12]. According to [2] the major problems faced by goat and sheep keepers in adoption of farming technology are lack of capital, lack of knowledge regarding improved breeds, non-availability of improved breeds, lack of training centers, lack of grazing land, high mortality in kids, lack of markets and non-availability of veterinary hospitals and doctors near to villages among others. In Kogi State, the peculiar problems of the goat and sheep farmers in adopting improved production technologies are lack of capital, lack of technical know-how regarding improved breeds, lack of training centers, high mortality in kids, lack of cooperative association, illiteracy, non-availability of veterinary hospitals and doctors near to villages among others (Recognizance Survey, 2021). Most previous studies [1] on goat and sheep production have focused on husbandry practices, effects or impacts of information communication technologies (ICT) dissemination such as mobile phones, radio, television, newspapers, and internet on either rural or urban farmers. This study is therefore shifting focus to ascertain the determinants of technologies adoption among small scale sheep and goat farmers in Kogi State.

Despite the benefits associated with the adoption of improved production technologies, it is observed that some small ruminant farmers are not practicing the technologies to improve their production. It is therefore important for an empirical study to be conducted to determine the adoption stages of the improved production technologies among the farmers in the study area and to determine factors influencing the adoption of the technologies. This will not only provide an indicator as regards the level of adoption of sheep and goat technology introduced to farmers but also ascertain the factors that determine the adoption. It is expected that the findings will enhance effective policy implementation and strategy design for the technology adoption.

Methodology

The study was carried out in Kogi State of Nigeria. Kogi State was carved out from Kwara and Benue states, on 27° August 1991, having Lokoja as its state capital. Geographically, it is located between latitude 6°30'N and 8°48N, and Longitude 5°231E and 7°48'E. The state has a land area of 283,135,359km, (Kogi state Population Commission, KSPC, 2006). Kogi State has a total population of about 4, 957,780 people in 2020 (using the state projected growth rate of 3%) (NPC, 2006) with an average of 172,000 farming families. Rivers Niger, and Benue form a confluence, which creates an alluvial fertile soil which supports crop and livestock production. A multi-stage sampling technique was employed in selecting respondents for this study. First, the four agricultural zones namely, Zone A, Zone B, Zone C and Zone D were adapted. From each zone, two Local Government Areas (LGAs) were purposely selected giving a total of eight LGAs. This selection was based on the LGAs that are more involved in Sheep and Goat production. In the second stage, two communities were purposely selected giving a total of 16 communities. This selection was also based on the number of sheep and goat farmers in each community. In the third stage, random sampling was used to select 15 farmers from each community for both sheep and goat. The research therefore had a total respondent of 240 farmers: 120 for sheep and 120 for goat production in the study area. Data for this study was obtained from a primary source using a structured questionnaire. Obtained data were analyzed using descriptive and inferential statistics. The determinants of the level of adoption of improved sheep and goat production technologies were analyzed using an ordered probit regression model.

The implicit form of the model is given thus:

$Y^* = x^1\beta + e_i$

Where Y* is the exact but unobserved dependent variable

X is the vector of independent variables

β is the vector of regression coefficients to be estimated

$Y = (X_1 + X_2 + X_3 + \ldots\ldots\ldots\ldots X_n)$

Y = Number of technologies adopted

X_1 = Age of farmers in years

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X_2 = Sex (male = 1; otherwise = 0)

X_3 = Marital status (married = 1; otherwise,0)

X_4 = Education (years spent schooling)

X_5 = Household size (number)

X_6 = Farming experience (years)

X_7 = Herd size (number)

X_8 = Access to credits (Access=1; otherwise = 0)

X_9 = Extension contact (number of times in the last production cycle)

X_{10} = Membership of cooperative (membership=1; otherwise = 0)

Results and Discussion

Socioeconomic Characteristics of Sheep and Goats Farmers

Table 1: Socio-economic distribution of sheep and goat farmers in the study area.

	Sheep Farmers		Goat Farmers	
Variables	**Frequency**	**%**	**Frequency**	**%**
Age				
21-30	37	31	42	35
31-40	52	43	48	40
41-50	16	13	10	8
51 and above	15	13	20	17
Sub Total	**120**	**100**	**120**	**100**
Mean	**48**		**44**	
Marital status				
Married	82	68	71	59
Single	11	9	33	28
Divorce	17	14	12	10
Widowed	10	8	4	3
Sub Total	**120**	**100**	**120**	**100**
Household size				
6-Mar	27	23	35	29
9-Jul	46	38	56	47
12-Oct	19	16	22	18
13 and above	28	23	7	6
Sub Total	**120**	**100**	**120**	**100**
Mean	**8.2**		**9.6**	
Herd size				
4-Feb	16	13	22	18
6-May	38	32	24	20
9-Jul	56p	47	62	52
>9	10	8	12	10
Sub Total	**120**	**100**	**120**	**100**
Mean	**7.3**		**8.4**	
Farming experience (Years)				
10-Jan	58	48	52	43
20-Nov	37	31	44	37
21-30	19	16	14	12
>30	6	5	10	8

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Sub Total	**120**	**100**	**120**	**100**
Mean	**11.6**		**10.8**	
Education Acquired(years)				
6-Mar	72	60	52	43
10-Jul	25	21	37	37
14-Nov	20	17	27	12
15-18	2	2	4	8
>18	1	1	0	0
Sub total	**20**	**100**	**120**	**100**
Mean	**8.1**		**9.8**	

Source: Field survey 2020

The socioeconomic characteristics of sheep and goat farmers in the study area is presented in (Table 1). Table 1 shows that small scale sheep and goats farming in the study area is embraced predominantly by the middle-aged. The result also shows that rearing of sheep and goats at small scale level is predominant among married people with a mean of 8 persons and 10 persons per household between sheep and goats' farmers respectively; this implies that farming households is large enough to provide sufficient family labour for the operation of their farm work and for their small-scale sheep and goats business. This is a positive indication that there would be more availability of family labour for taking care of these animals and therefore, a need to increase their herd size. An average of 12 years mean farming experience of rearing sheep and 11years mean experience of rearing goats respectively was recorded. The respondents attained various status of educational qualification. The level of awareness and adoption of agricultural innovations are influenced by the literacy status of farmers. Those who are literate are known to be more innovative than their counterpart because of their ability to get information more quickly and to take more risk.

Adoption of Improved Sheep and Goat Production Technologies

Table 2a: Adoption of improved sheep production technologies among the respondents.

Technologies	Awareness	Interest	Evaluation	Trial	Adoption
Supplementary feeding	19 (15.8)	13 (10.8)	31 (25.8)	25 (20.8)	32 (26.8)
Routine vaccination	22 (18.3)	31 (25.8)	29 (24.2)	30 (25.0)	08 (6.7)
Housing of animals	48 (40.0)	22 (18.3)	19 (15.8)	31 (25.9)	0
Mineral supplementation	89 (74.2)	27 (22.5)	04 (3.3)	0	0
Cleaning of pen	07 (5.8)	29 (24.2)	51 (42.5)	33 (27.5)	10 (8.3)
Detection and isolation of sick animals	0	07 (5.8)	55 (45.8)	48 (40.0)	66 (55.0)
De-thickening of animals	0	0	30 (25.0)	24 (20.0)	
Hoof trimming	39 (32.5)	42 (35.0)	11 (9.2)	16 (13.3)	12 (10.0)

Source: Field Survey, 2020

Figures in parenthesis are percentages.

The adoption of improved sheep and goat production technologies among the respondents are presented in (Table 2a) and (Table 2b), respectively. Farmers' stages of adoption were assessed using the common five (5) adoption categories in agricultural extension. These categories include awareness, interest, evaluation, trial, and adoption. The result shows spatial distribution of sheep and goat farmers at various stages of adoption in the adoption category. It was revealed that most of the sheep farmers adopted de-thickening (55%) and supplementary feeding (26.8%). Table 2a also reveal that 74.2% and 40% of the sheep producers sampled for this study were still at the awareness stage in the adoption of mineral supplementation and housing of animals, respectively, while 50.8% were found at the interest stage in the adoption of mineral supplementation. For the adoption of improved goat production technologies, Table 2b shows that 65% of the goat producers adopted de-thickening technology in goat production. Furthermore, 45% and 30% of the goat producers were found at the final stage in the adoption of supplementary feeding and isolation of sick animals, respectively. The majority (74.2%) of the goat farmers were found at the awareness stage in

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the adoption of hoof trimming technology among the goat farmers, while 50.8% were at the interest stage in the adoption of mineral supplementation. Generally, there is relatively moderate adoption of improved sheep and goat production technologies among the respondents. Farmer may decide not to adopt a technology if the proposed technologies do not meet their needs, or if the cost of adopting the technology is high more than they can afford and if they feel that the benefit accruing from the adoption of the technology may be very low [13].

Table 2b: Adoption of improved goat production technologies among the respondents

Technologies	Awareness	Interest	Evaluation	Trial	Adoption
Supplementary feeding	11(9.2)	22(18.3)	16(13.3)	17(14.2)	54(45.0)
Routine vaccination	25(20.8)	19(15.8)	49(40.8)	15(12.6)	12(10.0)
Housing of animals	23(19.2)	29(24.2)	41(34.2)	17(14.2)	10(8.2)
Mineral supplementation	09(7.5)	61(50.8)	42(35.0)	0	08(6.7)
Cleaning of pen	0	18(15.0)	44(36.7)	52(43.3)	06(5.0)
Detection and isolation of sick animals	03(2.5)	33(27.5)	29(24.2)	19(15.8)	36(30.0)
De-thickening of animals	01(0.8)	0	22(18.4)	19(15.8)	78(65.0)
Hoof trimming	89(74.2)	22(18.3)	09(7.5)	0	0

Source: Field Survey, 2020

Figures in parenthesis are percentages.

Determinants of Adoption of Improved Sheep and Goat Production Technologies

Table 3: Regression results on the determinants of adoption of improved sheep and goat production technologies.

Variables	Sheep			Goat		
	Coeff.	Std. Error	P>/z/	Coeff.	Std. Error	P>/z/
X_1 Age	-0.0298	0.0188	0.114	-0.0243	0.0178	0.174
X_2 Gender	-0.4102	0.2514	0.103	-0.3627	0.2804	0.196
X_3 Marital status	0.0247	0.2363	0.917	0.1889	0.2165	0.383
X_4 Education	0.0174	0.0395	0.659	0.0524	0.0382	0.17
X_5 Household size	-0.0563	0.0734	0.443	-0.0393	0.0603	0.515
X_6 Farming exp.	-0.023	0.0239	0.336	-0.0075	0.0241	0.756
X_7 Herd size	0.0326	0.0385	0.398	0.0693	0.0381	0.069*
X_8 Credit access	0.2635	0.2499	0.292	0.263	0.2561	0.304
X_9 Ext. contact	1.0987	0.2207	0.000***	1.0218	0.2062	0.000***
X_{10} Coope. Mem.	1.5972	0.5982	0.008***	1.3822	0.5845	0.018**
LR Chi^2	45.93		0.0000***	56.74		0.0000***
Log likelihood	-140.704			-156.147		
Psedu R^2	0.1403			0.1537		

Source: Field Survey, 2020

Note: ***, ** and * = significant at 1%, 5%, and 10%, respectively

Table 3 shows the determinant of adoption of the eight (8) improved sheep and goat production technologies by the respondents. From the result of the Ordered Probit Regression on Table 3a, the chi-square value, significant at 1% for both sheep and goat production imply joint effect of included explanatory variables on the adoption of improved sheep and goat production technologies in the study area. Out of the ten (10) included independent variables, two (extension contact and cooperative membership) significantly influenced the adoption of improved sheep and goat production, while herd size significantly influenced the adoption of improved goat production.

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The coefficient of extension contact was positive and statistically significant to farmers' adoption of improved technologies in sheep and goat production at 1% alpha level respectively in the study area. The implication is that frequency of extension contact for dissemination of information and advisory services could encourage farmers to have confidence to sustain the use of production technology packages [14]. The influence of extension contacts can counterbalance the negative effect of poor access to formal education in the overall decision to adopt certain technologies, hence creating better awareness about the potential gains of improved agricultural innovations [9]. This is in tune with [15] who reported that increase in the number of extension visits and services offered to farmers can significantly enhance decision making ability for technology adoption. This is in accord with the findings of [16] who recorded a positive coefficient of extension contact and statistically significant to level of adoption of improved rice technologies.

The coefficient of cooperative membership was positive and only statistically significant to adoption of improved technologies in goat production. Membership of a cooperative enables farmers to interact with other farmers, share their experiences and assist themselves in one way or the other. Interaction of farmers with other farmers is an avenue through which innovation diffusion takes place. According to [17], membership of a cooperative or any farming group is a major determinant of adoption of cassava varieties in Benue State. Similarly [18], revealed that membership of cooperatives enhances members 'efficiency by easing access to productive inputs and facilitating extension linkage when compared to those who were not members. This agrees with the findings of [16] who also recorded a positive coefficient of cooperative membership and statistically significant to level of adoption of improved rice technologies.

The coefficient of herd size was positively related to the adoption of sheep and goats' technologies and significant at 10 % for goat production. This is in line with the a priori expectation. Farmers with large herd size are usually known to be early adopters [19]. This finding concurred with [20], who reported that lumpy technologies such as mechanized equipment requires economic of size of land to ensue profitability. Conversely [21], opined that small size farms may provide an incentive to adopt technology especially in the case of input intensive innovations such as labor-intensive or land solving technology (Green house technology and zero grazing). Furthermore, the negative relationship between farming experience and adoption of improved sheep and goat production technologies agrees with [16] who had negative relationship in farming experience and statistically insignificant to level of adoption of improved rice technologies.

The result shows that the coefficient of age of the farmer was negative, though not significantly signed at the level of measurement. The negative relationship could imply that youthful farmers can adopt technologies more easily than older ones, as they (youthful farmers) are more adventurous, motivated, more educated, and adaptive [20]. This corroborates with the findings of [16] who recorded negative in age and statistically insignificant to level of adoption of improved rice technologies. The negative relationship between household size and adoption of improved sheep and goat production technologies implies that an increase in the number of persons in a household will decrease the adoption level. This finding agrees with [22] who reported that large household members could be a burden especially, where the members are not of labour age and more of dependent population. Also as expected, the coefficient of levels of education had a positive relationship to the adoption of improved technologies in sheep and goats' production and significant. Education according to [23] influences the farmer's managerial ability, skill, and receptivity to technology adoption. In the same vein [25], reported that the level of educational attainment by farmer could not only increase his farm productivity but also enhance his ability to understand new production technologies. This is contrary with the findings of [16] who had negative coefficient of levels of education and statistically insignificant to level of adoption of improved rice technologies.

Conclusion and Recommendations

From the results of this research, routine vaccination, de-thickening of animals, hoof trimming, and use of mineral supplement were the relevant improved technologies that were adopted by the goat and sheep farmers in the study area. Herd size, extension contact, and cooperative membership were positive and statistically significant in influencing the adoption of improved technologies in sheep and goat production. Based on the findings of this study, the following recommendations were suggested as a means of improving the adoption of improved technologies in the production of sheep and goat production in the study area.

i. Agricultural extension agencies should intensify more efforts and engage in intensive extension campaign on adoption of improved technologies and proper and continuous demonstration of these technologies to farmers especially at the trial stage and encourage the goat and sheep farmers to form association.

ii. The government should help to encourage extension service delivery in the state-owned Agricultural Development Programs (ADP). This can be achieved by the government through adequate funding of ADP and prompt payments of incentives to extension agents. This will help to make available extension materials and educate them on the type of technologies to adopt and to also help to mobilize and motivate the extension agents to be able to reach more of the target farmers (sheep and goats' farmers) with relevant information on improve agricultural practices to improve the farmer's profits level.

iii. Government should try and subsidized veterinary drug for farmers to reduce their cost of production and make available qualified veterinary doctors who will treat these animals when they are sick at a cheaper price, as this will increase scale of production and avail farmers to utilize economies of scale.

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