IMPACT OF PAN-AFRICAN TSETSE AND TRYPANOSOMIASIS ERADICATION CAMPAIGN INTERVENTION ON HERD SIZE AMONG CATTLE FARMERS IN JIGAWA AND NASARAWA STATES, NIGERIA

Achagwa, S. M., Sennuga, S. O., Ajah, J., Haruna, L. Z., Ajunwa, L. O., Chukwu, I. L., Hassan, M, Agbadoronye, P.C and Lawal, D
Department of Agricultural Extension and Rural Sociology, University of Abuja, Nigeria
Achagwalisticachagwa1@gmail.com, +2348036129180

ABSTRACT

The study assesses the impact of Pan-African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) intervention on herd size in Jigawa and Nasarawa States, Nigeria. The specific objectives are to: *describe the socio-economic characteristics of cattle rearers in the study area, compute the impact of PATTEC on herd size in the study area, and identify the constraints militating against cattle rearing activities in the study area. Multistage sampling techniques were used to sample 640 respondents for the study. The socio-economic characteristics of the respondents indicated that the majority (82.2%) of cattle rearers in Jigawa State are male, while only 17.8% were female. Cattle rearing is a male-dominated activity in Nasarawa State, with 93.1% of respondents being male and only 6.9% female. The average age of cattle rearers in both Jigawa and Nasarawa States was 47 years. The majority of farmers in Jigawa (91.3%) and Nasarawa (96.2%) states were married, suggesting that cattle rearing is a major livelihood activity for family heads who provide for their households. The results revealed that 66.5% of cattle rearers in Jigawa State had no formal education; in Nasarawa State, more than half of the respondents (52.0%) had no formal education. The average farming experience of the farmers in both states was 28 years. The mean household size of farmers in Jigawa State was 8, while Nasarawa State was 12. The average annual income of cattle rearers in Jigawa and Nasarawa States was ₦3,028,393.1 and ₦2,282,368.75, respectively. The propensity score matching analysis revealed that the impact of the intervention on the entire population (participants and non-participants; ATE) is 1.29, while the average impact for those who actually received the treatment (participants) is 2.15. Both the ATE and ATET are statistically significant at the 1% level ($p < 0.01$). The study revealed that the major constraints faced by cattle rearers in the study area were conversion of cattle routes to crop fields, Tsetse and Trypanosomiasis diseases, Access to capital/credit/finance, Lack of infrastructure, such as housing, electricity, Cost and lack of vaccine, Transportation cost of cattle for sales to far places-farmers clashes, cattle rustling, water scarcity in the dry season, lack of adequate veterinary services, and poor cattle insurance etc. Based on the socioeconomic characteristics of farmers in both states, which revealed lower levels of education, the study recommended that the government establish adult education programs in the States or strengthen existing ones, as education is key to the adoption of technologies. Similarly, based on the result of propensity score matching the study revealed that ATE and ATET are both statistically significant at the 1% level ($p < 0.01$) therefore, the study recommended that Federal Ministry of Livestock Development, should take decisive action by strengthening veterinary support, increasing the number of trained personnel, and ensuring the availability of affordable and accessible animal healthcare services to sustain the gains of PATTEC. Furthermore, the result of the analysis revealed that the major constraints militating against cattle rearing activities should be addressed by the government and PATTEC project sponsors; among other constraints are farmers and herders clashing, access to credit facilities, infrastructure, vaccines, transportation means, insurance cover, water during dry season, and security of farmers and herders in the study area to boost farmers' herd size.*

Keywords: Tsetse, Trypanosomiasis, cattle rearing.

INTRODUCTION

According to Sultan and Mohammed (2021), cattle rearing is the practice of raising and managing cattle, for purposes such as producing meat, milk, leather, and other products. Global cattle rearing is a widespread agricultural activity that is crucial in food production, economic stability, and rural livelihood. It focuses on raising cattle for meat, milk, leather, and other byproducts. According to the FAO (2024) projection, global meat consumption is expected to increase to 3.5 kg per person by 2030. In the same vein, Nick, Andrew, Jeremy, and Warrant (2022) opined that meat provides 11% of global food energy, 29% of dietary fats and 21% of protein.

According to Henk and Wouter van der (2023) cattle rearing in Africa, supports millions of livelihoods and contributes significantly to local economies and food security. Furthermore to feed the fast-growing population much more food must be produced in the same vein not just more calories but also more proteins, from meat and milk which requires more productive livestock. In addition annual per capita meat consumption in Sub-Saharan Africa (SSA) is only one-third the world average and for dairy consumption, the ratio is similar and even declining.

According to Lucia, Ugo and Dominik (2020) population growth, raising income and urbanization has fueled a significant increase in demand for animal products in developing countries like Nigeria. In the same vein cattle rearing in Nigeria is a prominent agricultural activity particularly in northern Nigeria. It plays an essential role in the country's food production, economic development and cultural heritage. According to Kubkomawa (2017) Nigeria consume 360,000 metric tonnes of beef annually. In Lagos alone 8,000 cattle are slauthered every day. In North West Zone of Nigeria cattle production is a profitable enterprise offers potential investment opportunity for income generation despite challenges of cattle farming in the area (Relwot, Abdulsalam, Yusuf and Oyinbo, 2021).

According to PATTEC (2001) tsetse and trypanosomiasis is a constraints to rural development. The disease threatens 100 million heads of cattle and economic development. Every year Africa loses over 3million cattle. The disease reduces meat, milk and other cattle products. Controlling and treatment are estimated at USD 4.5billion per year.

According to FAO (2023), tsetse and trypanosomiasis kill animals used for draught power, thus reducing the capacity of farmers. According to Ana (2023) tsetse and trypanosomiasis disease threatens about 60 million people and 48 million cattle in Africa. Individual country solutions would not work in controlling this menace. When Tsetse and trypanosomiasis disease is controlled, it re-infests over time. Similar campaigns around the world motivated the establishment of the PATTEC Project to control this menace.

PATTEC project was established in Lome during the OAU summit of Head of States and Government in July 2000. The main role is to promote at the highest political level control of tsetse and trypanosomiasis disease and the campaign represent a strong pan African commitment to fight against the disease (WHO, 2023). In 2001, FAO adopted a resolution (4/2001) requesting support from African Member States and the PATTEC initiatives in efforts to combat effectively human and animal trypanosomiasis disease and their vector. The IAEA adopted a resolution (GC (45)/RES/12) welcoming the plan of action of the Organization of African Unity (OAU) now African Union for the eradication of tsetse in Africa and furthermore, calling upon Member States to provide technical, financial and material support from African States in their

efforts to control and eradicate tsetse flies (WHO, 2023).

PATTEC headquarters is in Addis Ababa Ethiopia. It has project coordinating offices in all member countries of OAU including Nigeria. In Nigeria the coordinating office is located in Nigerian Institute for Trypanosomiasis Research Kaduna. The Director General and Chief Executive of the institute is Dr. J. J. Ajakaiye and the Project Officer of the Project is Dr. Rolayo Toyin Emmanuel. The project is optional and funded by Organization of African Unity (OAU) now African Union (AU), African Development Bank (AfDB), Food and Agricultural Organization (FAO), World Health Organization (WHO), and International Agency for Atomic Energy (IAEA).

Different control measure and campaign is ongoing to control and eradicate tsetse and trypanosomiasis disease. Modern methods include capacity building for cattle rearers, the use of Insect Sterile Techniques, breeding and rearing of trypatolerant cattle. The use of insect repellents, spraying tsetse breeding and resting site with insecticide, use of insecticides for aerial spraying, use of modern traps, use of treated nets, avoidance of insect bite etc. Traditional methods used in controlling tsetse flies include clearing wood land and periodic burning, clearing vegetation, burning grass and bush, use of smoke and fire, traditional traps, seasonal grazing, grazing timing, etc.

Modern methods of treating tsetse and trypanosomiasis disease include isolation and screening of infected cattle and humans, use of drugs like pentamidine and suramin for human trypanosomiasis etc. Traditional methods of treatment of trypanosomiasis include herbal infusions and decoctions, herbal pastes are applied to wounds, bloodletting practices, use of ashes, salts, and healing rituals, use of amulets and charms, dietary and rest practices etc. Those practices often limited by lack of scientific validation. However, integrating traditional knowledge with modern techniques can enhance the success of control programs.

Researches through the literature show that little or no work has been documented on impact of PATTEC on cattle rearers in Nigeria particularly in Jigawa and Nasarawa Statess. PATTEC project having operated over five years in Nigeria, hence, this study seek to find out if PATTEC project has impacted positively on the income of cattle rearers in the study area or not.

Objective of the study

The broad objective of this study is to examine the Impact of Pan-African Tsetse and Trypanosomiasis Eradication Campaign Intervention on Herd Size among Cattle Farmers in Jigawa and Nasarawa States, Nigeria.

The specific objectives are to:

i. describe the socio-economic characteristics of the respondents in the study area;

ii. compute the impact of PATTEC on herd size in the study area, and

iii. identify the constraints militating against cattle rearing activities in the study area.

Materials and methods

Study Area

According to the Jigawa State Government Bulletin (JSGB, 2023), Jigawa State was excised from Kano State. It covers a total land area of about 22,410 sq km. Jigawa State has twenty-seven (27) local government councils. The topography of the state is generally flat. The state lies between latitudes 11°N and 13°N and longitudes 8°E and 10°35'E with a tropical climate. The daily minimum and maximum temperatures are 15 degrees and 35 degree Celsius. The rainy season lasts from May to

September with average rainfall of between 600 millimeters to 1000 millimeters. Jigawa State has a savannah climate suitable for livestock farming. It has extensive grasslands, seasonal rivers, and grazing reserves that support cattle rearing. Jigawa State is one of the regions where animal trypanosomiasis is a significant concern. The disease mainly affects cattle and other livestock, leading to weight loss, reduced milk and meat production, abortions in pregnant animals, and death in severe cases; this causes major economic losses for farmers.

Nasarawa State Bulletin (NSGB, 2023). Geographically, Nasarawa State lies within a region bounded by Latitudes 7° 50' and 9° 50' N and Longitudes 6° 54' and 9° 54' E. It is located in the middle belt zone of the country. The state has a landmass of 28,116.8 square kilometers with Lafia as the Capital city. Nasarawa also has 13 Local Government Areas. Cattle rearing is a major agricultural activity in Nasarawa State. It significantly contributes to income generation, employment, and food supply, particularly in meat and dairy. Nasarawa's vegetation, rivers, and humid zones provide a suitable habitat for tsetse flies. The disease is more prevalent in animals, especially cattle, causing serious economic losses to farmers.

Population of the Study

The populations of the study were cattle rearers who participated in the PATTEC project in Jigawa State and cattle rearers who did not participate in the PATTEC project in Nasarawa State. In Jigawa State, the population covered two (2) agricultural zones, namely Gumel and Hadeja zones, Ringim, Garki, Kafin Hausa and Auyo Local Government Areas. In addition, the population of the study covered 16 blocks, 32 cells, and 320 cattle rearers. Similarly, in Nasarawa State, the population included two (2) agricultural zones, namely Obi and Keffi zones, Awe, Keana, Keffi and Nasarawa Local Government Areas. Finally, the population of the study covered 16 blocks, 32 cells, and 320 respondents given a total of 640.

Sampling Techniques and Sampling Size

The Multistage Sampling Technique:

The study used a multistage sampling technique to choose 640 respondents.

First Stage: Purposive Selection of States

The first stage, was purposive selected of two States, Jigawa and Nasarawa, from the 36 states and the Federal Capital Territory (FCT), Abuja. The rationale for choosing Jigawa State is because it is notable for being the first state in Nigeria where the PATTEC project was launched, making it a key area of interest. This state has a long-standing tradition of cattle rearing, with these activities thriving for many decades and continuing till date. On the other hand, Nasarawa State was chosen because PATTEC project was not in the State. Again, Nasarawa State is primarily known for its cattle-rearing activities and it is significant part of their livelihood activities. Just like in Jigawa, the cattle-rearing sector in Nasarawa has faced serious challenges due to tsetse flies and trypanosomiasis. This has led to a decline in both the quality and quantity of cattle produce like meat and milk, ultimately impacting the livelihoods of farmers in the State.

Second Stage: Purposive choosing of Agricultural Zones

In the second stage, two agricultural zones from each of the two States were selected resulting in a total of four zones. They were selected because they are mainly known for their cattle-rearing activities.

Third Stage: Randomly picked four blocks

Four blocks were randomly selected from each of the eight LGAs, resulting in thirty-two (32) blocks overall. This random selection was crucial to minimizing any bias in the sampling process.

Fourth Stage: Randomly selected 20 cattle rearers

Finally, in the fourth stage, we randomly selected 20 cattle rearers from each of the 32

blocks, leading to a total sample size of 640 respondents for the study.

Sources of Data Collection

Primary data were collected through questionnaires, while secondary data were obtained from publications by the Federal Ministry of Agriculture, the Agricultural Development Programme (ADP), the Local Government Department of Agriculture, books, journals, and journal articles.

Design of Instrument for Data Collection

The Instrument for data collection was a structured questionnaire. Two different questionnaires were designed. One (1) for Jigawa State (participants of PATTEC project) and two (2) for Nasarawa State (Non-participants of PATTEC project). The questionnaires were designed into sections. Section A: Socio-economic characteristics of cattle rearers/general questions.

Section B: Income/output from cattle rearing activities.

Section C: Constraints militating against cattle rearing activities in the study area.

Content Validity of Questionnaire

The questionnaires were validated by my supervisors and other lecturers in the Department of Agricultural Extension and Rural Sociology, Agricultural Economics, amongst others, to see that the questionnaire addressees the objectives of the study.

Reliability test of Questionnaires

The reliability or pilot test was carried out for this study. It allows researchers to identify and address potential issues before implementing the full-scale study. In conducting the reliability test, 10% of the questionnaires were administered in a location different from the study area. This was carried out in Abuja. The result of Cronbach's alpha was 0.715, which implies that the questionnaire was 71.5% reliable. Cronbach's alpha is the most common measure of internal consistency ("reliability"). It is most commonly used when you have multiple Likert questions in a survey/questionnaire that form a scale and you wish to determine if the scale is reliable (Frost, 2024).

Administration of Questionnaire

Trained ADP extension workers that understood the terrain of the study area, speak and understand Fulfulde Language of the respondents, were used in the administration of instruments for data collection. Furthermore, Executive members of Miyatti Allah Cattle Breeders Association of Nigeria and Animal Science Association of Nigeria in both Jigawa and Nasarawa State assisted in the administration of questionnaires during data collection

Method of Data Analysis

Descriptive and inferential statistics were used to analyze data for the study. The data collected from the field were analyzed with IBM SPSS version 25. After analysis, the research findings were put into categories based on the research objectives and presented through the use of tables, bar charts, and pie charts.

Objectives 1 and **3** were analyzed using descriptive statistics such as frequency, percentage and mean. **Objective 2** was analyzed using propensity score matching.

Results and Discussions

Socio-Economic Characteristics of Cattle Rearers in Jigawa and Nasarawa State

The results in Table 1 indicate that the majority (82.2%) of cattle rearers in Jigawa State were male, while only 17.8% were female. This aligns with previous studies that highlight cattle rearing as a traditionally male-dominated activity due to its labor-intensive nature (Adebayo and Olaniyi, 2008). For example, if a Veterinary Doctor wants to physically restrain a cattle to take a blood sample from the jugular

vein, it will need strong men to do so.

The percentage of female farmers is very low (17.8%), and this may be attributed to the fact that their roles are mostly rendering support to their husbands; for example, taking care of calves that cannot walk a far distance for grazing, milking cattle, and processing the milk for sale to generate income for their families. Female farmers also take care of their home, such as cooking, cleaning, taking care of children, among others. The study revealed that cattle rearing is a male-dominated activity in Nasarawa State, with 93.1% of respondents being male and only 6.9% female. This aligns with findings from previous studies such as Akinwumi (2019) and Okoruwa (2020), which indicated that traditional livestock farming, particularly cattle rearing, is largely undertaken by men due to the labor-intensive nature of the occupation. Women's participation remains low because their role is mostly supportive to their husbands, such as taking care of the family, cooking, cleaning, milking of cow, processing the milk and selling them to generate income for the families, among others responsibilities.

The age distribution of cattle farmers in Jigawa State shows that the average age of cattle rearers was 47 years, with most falling within 41–50 years (37.0%) while 33.3% were at least 51 years old. This suggests that cattle rearing is predominantly practiced by middle-aged farmers. Middle age represents the prime stages of life during which cattle rearing possesses both the physical strength and the experience required to carry out cattle rearing activities efficiently and effectively. Also, older farmers (51years and above) were farmers who are highly experienced, having spent many years in cattle rearing activities.

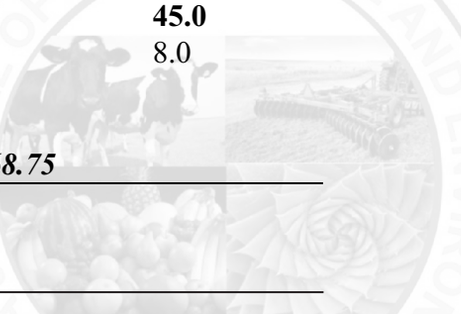
The low percentage (1.6%) of youth involvement in cattle rearing indicates a declining interest among younger generations, which could threaten the sustainability of the cattle industry in the State (Adesiji *et al.,* 2013). The mean age of respondents in Nasarawa State was 47 years, with 66% of cattle rearers being above 40 years. This suggests an aging cattle-rearing population, which may have implications for the sustainability of the industry. A study by Alhassan (2021) noted that an aging farmer population can reduce the adoption of modern livestock management practices, thus affecting productivity.

A significant majority (91.3%) of cattle rearers in Jigawa State were married, while only 4.1% were single, and the rest were either divorced (1.3%) or widowed (3.4%). A similar study by Adebiyi (2019) reported that married people are more responsible and could be due to the struggle to meet the needs of the family and the provision of labour for cattle rearing activities. In addition individuals tend to be more involved in stable economic activities such as livestock farming to provide for their households. Similarly, 96.2% in Nasarawa State were married, suggesting that cattle's rearing is a major livelihood activity for family heads who provide for their households. This trend aligns with previous research by Usman and Mohammed (2020), which found that livestock rearing is primarily managed by married men, who view it as a stable economic activity for supporting their families.

Table 1: Socio-Economic Characteristics of Cattle Rearers in Study Area

	Jigawa State		Nasarawa State	
Variables	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Sex				
Male	263	**82.2**	298	**93.1**
Female	57	17.8	22	6.9
Age				
≤ 20	5	**1.6**		
21 – 30	47	14.6	9	3.0
31 – 40	43	13.5	99	31.0
41 – 50	119	**37.0**	126	**39.0**
≥ 51	106	**33.3**	86	**27.0**
Mean	***47***		***47***	
Marital Status				
Single	13	4.1	6	1.9
Married	292	**91.3**	299	**96.2**
Divorced	4	1.3	6	1.9
Widowed	11	3.4		
Educational Level				
No formal education	210	**66.5**	167	**52.0**
Primary school	67	21.2	53	16.0
Secondary school	29	9.2	60	19.0
Tertiary school	10	3.1	40	13.0
Years of Farming				
1-10	28	8.8	53	16.6
11-20	84	**26.0**	181	**56.5**
21-30	97	**30.4**	47	**14.7**
> 30	111	**34.8**	39	**12.2**
Mean	***28***		***28***	
Household Size				
≤ 5	116	37.9	37	12.0
6 – 10	114	**37.2**	152	**50.0**
11 – 15	60	19.7	26	8.0
>15	16	5.2	92	30
Mean	***8***		***12***	
Income (Naira)				
< 1,000,000	4	1.2	20	6.0
1,000,001-2,000,000	60	19.1	131	41.0
2,000,001-3,000,000	122	**38.7**	144	**45.0**
3,000,001-4,000,000	69	21.7	25	8.0
4,000,001-5,000,000	44	13.7		
>5,000,000	21	6.6		
Mean	***3028393.1***		***2282368.75***	

Source: Field Survey, 2025



Impact of PATTEC on herd size of Cattle Rearers Participating in PATTEC Project Baseline Analysis of PATTEC Project Participants and Non-participants

The baseline analysis Table 2 compared the socioeconomic characteristics of participants (treated group) and non-participants (control group) of the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC). Results showed no significant difference in age between the two groups, indicating that both participants and non-participants were within similar age ranges. However, there were statistically significant differences in household size, years of farming experience, gender, marital status, and educational level ($p < 0.05$). Participants generally had smaller household sizes, slightly higher educational levels, and more farming experience compared to non-participants, suggesting some socio-demographic differences that can affect income. Baseline analysis was conducted to examine differences in socioeconomic and farm-level characteristics between project participants and non-participants prior to impact estimation. This comparison is essential for assessing potential selection bias and establishing initial comparability between the two groups. Consistent with recent impact evaluation literature, descriptive statistics, mean difference tests, and standardized mean differences (SMD) were employed to evaluate balance in observable characteristics (Khandker et al., 2022; Wossen et al., 2021). Establishing baseline

Table 2: Baseline Analysis of PATTEC Participants and Non -participant Cattle Rearers

Covariates	Group	Obs	Mean	Std. Err.	Std. Dev	95% Conf. Interval		t -value	p = value
Age	Treated	320	46.89	0.716	12.81	45.48	48.30	-0.436	0.663
	Control	320	46.51	0.526	9.41	45.47	47.54		
Household	Treated	306	7.81	0.256	4.48	7.31	8.31	t =	.000
Size	Control	307	11.87	0.402	7.03	11.08	12.66	8.517,	
Years of		320	31.13	0.532	9.52	30.08	32.18	t = 3.32	.001
Farming	Treated								
Experience	Control	320	28.27	0.677	12.12	26.94	29.60		
Gender	Treated	320	.821	.0214	.383	.780	.864	t = 4.26	.000
	Control	320	.931	.0141	.253	.903	.959		
Marital	Treated	320	.912	.016	.283	.881	.944	t =	0.0117
Status	Control	311	.961	.011	.193	.939	.983	2.529	
Educational	Treated	320	.328	.0263	.470	.277	.379	t = -	.000
Status	Control	320	.166	.0208	.372	.125	.207	4.846	

Source: Field Survey, 2025

Impact of PATTEC on the Herd Size

Pre-estimation Analysis of PATTEC Participants and Non-participants' Output (Herd Size) using Independent t-statistics

With reference to Table 2 the results of the baseline analysis show that PATTEC project participants and non-participants have different socioeconomic characteristics. The background difference provides a reference point for Pre-estimation analysis of PATTEC participants and non-participants' output (no of cattle reared) using independent t-statistics.

The pre-estimation analysis in Table 3 is the comparison of the output of participants and non-participants without looking at the baseline characteristics. Hence, we need to compare further participants and non-participants with similar backgrounds.

Table 3 : Pre -estimation Analysis of PATTEC Participants and Non -participants' Output (Number of Herds Size Reared) using Independent t-statistics

Group	Obs	Mean	Std. Err.	Std. Dev	95% Conf. Interval	
Participants	320	15.10313	.1739162	3.111107	14.76096	15.44529
Non-participants	247	14.59514	.4639237	7.291133	13.68137	15.50891
t = -1.1213		df = 565		p = 0.2626		

Source: Field Survey, 2025

Linear Regression of the effects ofH Socio-economic characteristics on Number of Herds Size of Cattle Rearers

The regression analysis in Table 4 provided deeper insights into the determinants of herd size among cattle rearers in the study area. The results revealed that the coefficient of determination (R^2) obtained from the linear regression analysis of 0.265 implies that the socio-economic characteristics of PATTEC project participants, such as gender, age, marital status, household size, education, and year of experience, together influence the herd size of farmers by about 27%. The remaining unexplained variation could stem from other contextual factors not captured in the model. This study agreed with Onyango (2025) on his study titled impact of choice and Integration of tsetse fly and trypanosomiasis control methods on household income in Lemu county Kenya. The study evaluates how integrated tsetse and trypanosomiasis control methods linked with PATTEC activities affected household income using OLS to estimate income effects.

Table 4: Linear Regression of the effects between Socio-economic characteristics on Number of Herds Size of Cattle Rearers

Variable	Coef.	Std. Err	t	P>|t|	95% Conf. Interval	
Gender	-1.229404	.7173788	-1.71	0.087	-2.638696	.1798875
Age	-.1028542	.0342738	-3.00	0.003	-.1701851	-.0355234
Marital status	.5523078	1.025922	0.54	0.591	-1.463117	2.567733
Household size	-.1514411	.0520037	-2.91	0.004	-.2536024	-.0492799
Education	-.4590227	.5360078	-0.86	0.392	-1.512011	.5939654
Years of Experience	.3461739	.0293737	11.79	0.000	.2884692	.4038786
Constant	11.35152	1.297337	8.75	0.000	8.802897	13.90014
Number of Obs	= 531					
F(6, 524)	= 31.45					
Prob > F	= 0.000					
R-squared	= 0.2648					
Adj R-squared	= 0.2563					
Root MSE	= 4.6106					

Source: Field Survey, 2025

Estimate of the Impact of PATTEC on the Output of the Farmers (Number of Cattle Rerared)

The treatment effects analysis provided robust empirical evidence on the impact of the PATTEC intervention on herd size among cattle rearers. The results in table 5 revealed that the impact of the intervention on the entire population, both participants and non-participants (ATE) is 1.29, while the measures of the average impact of only those who actually received the treatment (participants) is 2.15. Both the ATE and ATET are statistically significant at the 1% level ($p < 0.01$). Although the numerical increase may appear modest, it represents a meaningful gain within the context of smallholder and semi-pastoral production systems, where even a few additional animals can substantially enhance household income, asset value, and food security.

The positive and significant ATE indicates that the PATTEC intervention had a general effect across the entire population, reflecting possible spillover benefits of the program. Such spillover effects may have arisen from the reduction in tsetse infestation within surrounding areas, which improved cattle health even among non-participating households. In contrast, the larger ATET value (2.15) highlights the direct and more pronounced benefits experienced by actual participants. This difference suggests that households actively involved in PATTEC activities, such as the use of traps, spraying, and veterinary follow-up, achieved greater improvements in herd size compared to non-participants, who benefitted only indirectly from the broader vector control effects. This study is in line with Percoma *et al* (2018) Titled *Impact of an integrated control campaign on tsetse populations in Burkina Faso.* Reports *integrated tsetse control (PATTEC Burkina)* results with major livestock involvement and *mass treatment of livestock* a key input for analyzing herd productivity changes. Although focused mainly on vector density, it discusses improved livestock productivity outcomes (general increases expected due to lower disease challenge).

Table 5: Estimate of the Impact of PATTEC on the Output of the Farmers (Number of Herds Size Reared)

Treatment-effects estimation			No of observations	=	531	
Estimat : Nearest-neighbor matching			Matches: requested	=	1	
Outcome model: matching			Min	=	1	
Distance metric: Mahalanobis			Max	=	17	
Income	Coef.	AI Robust Std. Err	z	P>|z|	95% Conf. Interval	
ATE	1.289388	.3496276	3.69	0.000	.6041305	1.974646
ATET	2.152403	.3461024	6.22	0.000	1.474055	2.830751

Source: Field Survey, 2025

Post-estimation Analysis Using Standardized Mean Difference (SMD)

This post-estimation analysis in Table 6 assesses the balance in covariates between PATTEC participants (treated) and non-participants (control) before and after matching. The analysis applies the Standardized Mean Difference (SMD) and Variance Ratio methods to confirm whether the matching procedure effectively minimized pre-existing differences among cattle rearers.

The post-estimation analysis using the Standardized Mean Difference (SMD) was conducted to assess the adequacy of the matching procedure applied in estimating the treatment effects. The results revealed that after matching, the standardized mean differences for all covariates were very close to zero, indicating that the observable characteristics between the treatment (PATTEC participants) and control (non-participants) groups were well balanced. This balance suggests that the matching process, specifically the nearest-neighbor matching using the Mahalanobis distance metric, was successful in creating a valid counterfactual group for comparison.

In impact evaluation, achieving balance between treated and control groups is a critical diagnostic step, as it determines the credibility of causal inference. A small or near-zero SMD value implies that the differences in the means of covariates (such as age, education, household size, and years of experience) between the two groups are statistically insignificant after matching. In other words, both groups share similar socioeconomic and demographic characteristics, and any subsequent difference in herd size can be more confidently attributed to the PATTEC intervention rather than pre-existing disparities.

Furthermore, the post-matching variance ratios were found to be close to unity (1.0), further confirming that the distributions of the matched covariates were similar across both groups. This indicates that the model achieved satisfactory covariate balance, meeting the generally accepted thresholds proposed by Rosenbaum and Rubin (1985), which state that SMD values within ±0.10 The results, therefore, validate the reliability and robustness of the matching process employed in the study. By effectively minimizing selection bias, the analysis

enhances the internal validity of the estimated treatment effects and ensures that the observed positive impacts of PATTEC on cattle rearers' herd size are genuine program effects rather than artifacts of sample imbalance. In essence, the SMD values serve as empirical evidence that the propensity score matching (PSM) technique was appropriately specified and efficiently implemented in this study. The study is in line with Shi, Zhang, Lin, Kwan, and Tong (2025) titled *Geometric standardized mean difference and its application to meta-analysis. The study* proposes a novel geometric method for computing the SMD**,** with improved bias and precision when variances differ between groups useful *for post-estimation interpretation of effect sizes.*

Table 6: Post-estimation Analysis Using Standardized Mean Difference (SMD)

OBSERVATIONS			**Raw data**	**Matched**
Number of observations =			531	1,062
Treated observations =			306	531
Control observations =			225	531
Variable	Standardized Mean Difference		Variance Ratio	
	Raw data	Matched	Raw data	Matched
Gender	-.2551046	-.0261008	1.716188	1.051529
Marital status	.019539	0	.922216	1
Age# Household size	-.3782533	-.0448562	.6267444	.9077138
Education	.3260841	.0399765	1.52845	1.05146
Years of Experience ^{2}	-.1860694	.0011491	.9558087	1.149488

Source: Field Survery, 2025

Constraints Militating Against PATTEC Productivity by Rearers in Jigawa and Nasarawa States

The result in Table 7 showed the constraints affecting cattle rearing in Jigawa and Nasarawa States. In Jigawa State the most frequently reported constraints were the conversion of cattle routes to crop fields (66.6%), tsetse and trypanosomiasis (65.9%), and limited access to capital/credit/finance (65.6%). In Nasarawa State the leading challenges were high transportation costs for cattle sales to distant markets (65%), cost and unavailability of vaccines (63%), bad leadership of cooperative groups (63%), and migration/movement issues (62%). Other constraints commonly reported across both states included lack of quality feeds (50%), water scarcity in the dry season (50%), herder-farmer clashes (59.4% in Jigawa State 38% in Nasarawa State), cattle rustling (60.9% in Jigawa State 41% in Nasarawa State), and poor insurance coverage (44.1% in Jigawa State 43% in Nasarawa State). Less frequently reported challenges included poor market access (14.1% in Jigawa State 11% in Nasarawa State) and lack of adequate government support (16.9% in Jigawa State 16% in Nasarawa State). The high proportion of respondents reporting *tsetse and trypanosomiasis* in Jigawa aligns

with previous studies identifying African animal trypanosomiasis as a persistent challenge in Nigerian livestock systems, leading to reduced productivity and increased herd mortality Shaw (*et al*, 2015). This finding is consistent with the study which showed that shrinking grazing lands in Nigeria and the Sahel region, intensified farmer–herder conflicts and undermined pastoral mobility (Blench, 2017; Turner, 2021). Limited grazing access exacerbates feed shortages and increases the risk of violent clashes with farming communities.

Security-related issues, such as cattle rustling and farmer–herder conflicts, were also reported as major concerns. The prevalence of cattle rustling (61% in Jigawa State and 41% in Nasarawa State) underscores the rising insecurity facing pastoral communities. These findings mirror reports highlighting how rustling and rural banditry disrupt cattle production, reduce herd sizes, and discourage investment in improved husbandry practices (Okoli and Okpaleke, 2014; Fasona et al., 2020). The findings show that the challenges facing livestock production in Nigeria is multifaceted.

Table 7 : Constraints Militating Against Cattle Rearing Activities in Jigawa and Nasarawa States

	Jigawa State		Nasarawa State	
Variable	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Tsetse and Trypanosomiasis diseases	211	65.9	108	34
Herder's farmers clash	200	62.5	120	38
Cattle rustling	190	59.4	130	41
Water scarcity in the dry season	160	50.0	160	50
Conversion of cattle routes to crop fields	213	66.6	100	31
Lack of quality feeds	160	50.0	160	50
Poor cattle management practices	180	56.3	118	37
Poor market	45	14.1	34	11
Lack of adequate veterinary services	150	46.9	170	53
Cost and lack of vaccine	116	36.3	200	63
Access to capital/credit/finance	210	65.6	109	34
Migration from one place to another	105	32.8	198	62
Poor extension services	79	24.7	50	16
Poor Insurance of cattle	180	56.3	140	44
Bad leadership of the cooperative group	101	31.6	201	63
Transportation cost of cattle for sales to far places	110	34.4	209	65
Lack of infrastructure, such as housing, electricity, etc.	200	62.5	115	36
Lack of adequate government support for cattle rears	51	15.9	50	16
Pest and diseases of cattle, e.g., foot and mouth, brucellosis, bovine tuberculosis, bluetongue, etc.	186	58.1	130	41
Seasonal feed shortages (natural grasses, crop residues)	175	54.7	140	44

Source: Field Survey, 2025 (Multiple responses recorded)

Conclusion

The study assessed the impact of the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) on herd size in Jigawa States. The findings revealed that PATTEC interventions have contributed significantly to reducing the prevalence of tsetse flies and trypanosomiasis in the study areas. This has led to increase in the number of herds and consequently increased meat and milk production enhanced economic well-being of farmers.

The study revealed that the major constraints faced by cattle rearers in the study include conversion of cattle routes to crop fields, Tsetse and Trypanosomiasis diseases, Access to capital/credit/finance, Lack of infrastructure, such as housing, electricity, Cost and lack of vaccine, Transportation cost of cattle for sales to far places-farmers clashes, cattle rustling, water scarcity in the dry season, lack of adequate veterinary services, and poor cattle insurance etc.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. The socioeconomic characteristics of farmers in both states, which revealed lower levels of education, the study recommended that the government establish adult education programs in the States or strengthen existing ones, as education is key to the adoption of technologies.
2. The result of propensity score matching the study revealed that ATE and ATET are both statistically significant at the 1% level ($p < 0.01$) therefore, the study recommended that Federal Ministry of Livestock Development, should take decisive action by strengthening veterinary support, increasing the number of trained personnel, and ensuring the availability of affordable and accessible animal healthcare services to sustain the gains of PATTEC.
3. The result of the analysis revealed that the major constraints militating against cattle rearing activities should be addressed by the government and PATTEC project sponsors; among other constraints are farmers and herders clashing, access to credit facilities, infrastructure, vaccines, transportation means, insurance cover, water during dry season, and security of farmers and herders in the study area to boost farmers' herd size.

REFERENCES

Adebayo, S. A and Olaniyi, T. (2008). Gender Participation in Livestock Production in Nigeria. *Journal of Agricultural Extension* 12(2): 45-58.

Adebiyi, T. T. (2019): Rice Farmers' Participation in "USAID MARKET" Capacity Building and Its Effect on Their Output and Income. A Ph. dissertation submitted to the Department of Agricultural Extension and Rural Sociology Faculty of Agriculture, University of Abuja Nigeria.

Adesiji, G. B., Komolafe, S. E and Abdulwahab, A. (2013): Youth involvement in livestock production in Nigeria. *Nigerian Journal of Animal Science,* 35(1), 112-120.

Akinwumi, J. A. (2019): "Gender dynamics in livestock farming in Nigeria." *African Journal of Agricultural Research* 14(2): 134-145.

Alhassan, U. (2021): "Aging farming population and its impact on cattle production in Nigeria." *Nigerian Journal of Animal Science* 18(3): 112-128.

Ana, L. C. (2023): Tsetse Frees Areas https://analarcher.vwordpress.com/projects/tsetse-free-areas/. Accessed 28th August, 2023.

Blench, R. (2017). The Expansion of Cultivation and the Future of Pastoralism: A West African Case Study. *African Journal of Range and Forage Science, 34*(1), 5–12.

FAO (Food and Agriculture Organization) (2023): Projection of Global Meat Consumption. https://www.google.com/search?q=FAO%2C+(Food+and+Agricultural+Organization)+(2023)%3A+Projection+of+global+meat+consumption. Accessed 28th November, 2024.

FAO (Food and Agriculture Organization) (2024): Pest and Pesticide Management. https://www.fao.org/pest-and-pesticide-management/ipm/integrated-pest-management/en/. Accessed 21st December 2024 Pp1-2

Fasona, M. J., Omojola, A. S., and Oloukoi, G. (2020). Livelihoods Under Siege: Climate, Conflict and Insecurity in Nigeria's Pastoral Communities. *Pastoralism: Research, Policy and Practice, 10*(1), 1–14.

Frost, J. (2024): Cronbach's Alpha: Definition, Calculations & Example. https://statisticsbyjim.com/basics/cronbachs-alpha/.Accessed 1st September, 2024.

Henk, B and Wouter, V. (2023): Food Security in Africa Requires More Productive Livestock https://agrifoodnetworks.org/article/food-security-in-africa-requires-more-productive-livestock-1. Accessed 8th November, 2024.

JSGB, (Jigawa State Government) (2023): Jigawa State Government Background and History. https://jigawastate.gov.ng/about%20state.php. Accessed 9th September, 2023

Khandker, S. R., Koolwal, G. B., and Samad, H. A. (2022). *Handbook on impact evaluation: Quantitative methods and practices* (2nd ed.). World Bank.

Kubkomawa, H. I. (2017): Indigenous Breed of Cattle their Productivity, Economic and Cultural Values in Sub-Sahaan Africa. A review. *International journal of research studies* 3(1): 27-43.

Lucia, R. L., Ugo, P and Dominik, W. (2020): Africa the livestock revolution urbanizes. Www. Researchgate .net. Accessed 26th November, 2024.

Nick, W. S., Andrew, J. F., Jeremy, P. H and Warren, C. M. (2022): Modelling the Contribution of Meat to Global Nutrition Availability. Www.frontiers in .org. Accessed 26th November, 2024.

NSGB, (Nasarawa State Government Bulletin) (2010): Nasarawa State Government Background and History. https://nasarawastate.gov.ng/about-nasarawa-state/.Accessed 9th September, 2024.

Okoli, A. C., and Okpaleke, F. N. (2014). Cattle Rustling and Dialectics of Security in Northern Nigeria. *International Journal of Liberal Arts and Social Science, 2*(3), 109–117.

Okoruwa, V. O. (2020). "Challenges facing female livestock farmers in Nigeria." *Journal of*

Agricultural Extension, 24(1), 89-101.

Onyango, S. (2025): Impat of choice and integration of tsetse fly and trypanosomiasis control methods on household income in Lamu County, Kenya. (Unpublished thesis / working paper). University of Nairobi Kenya.

PATTEC, (Pan African Tsetse and Trypanosomiasis Eradication Campaign) (2001): Plan of Action.https://au.int/sites/default/files/documents/32888-doc-pattec_plan_of_action2001.pdf. Accessed 9th September, 2023.

Percoma, L., Sow, A., Pagabeleguem, S., Dicko, A. H., Serdebéogo, O., Ouédraogo, M., Rayaissé, J. B., Bouyer, J., Belem, A. M. G and Sidibé, I. (2018): Impact of an Integrated Control Campaign on Tsetse Populations in Burkina Faso. *Journal of Parasites and Vectors* 11(1): 270-286.

Relwot, G., Z., Abdulsalam, Z., Yusuf, O. and Oyinbo, O. (2021): Profitability of Beef Cattle Farming from the North West Zone. Www. researchgate.net. Accessed 8th November, 2024.

Rosenbaum, P. R. and Rubin, D. B. (1985): Constructing a Control Group Using Multivariate Matched Sampling Methods that Incorporate Score. *The American Statistician*, 39(1):33-38.

Shaw, A. P. (2015): "Benefits of Tsetse Control: A Review of the Evidence." *Pastoralism, 5*(1), 1-16.

Shi, J., Zhang, X., Lin, L., Kwan, H. Y., & Tong, T. (2025). *Geometric standardized mean difference and its application to meta-analysis. Accessed.* https://arxiv.org/abs/2506.03639. *Accessed 20th December, 2025*

Sultan, M and Mohammad, U. K (2021): Systematic Literature Review on Deep Learning Application for Precision Farming. Www. Science direct.com. Accessed 8th November, 2024.

Turner, M. D., Ayantunde, A. A and Patterson, K. P. (2021): Land use conflicts and the future of cattle grazing in West Africa. *Land Use Policy*, 107, 105490.

Usman, A and Mohammed, A. (2020): "The role of family structure in livestock production." *Journal of Rural Studies* 37(4): 256-272.

WHO, (World Health Organization) (2023): Trypanosomiasis Human African (Sleeping Sickness). https://www.who.int/news-room/fact-sheets/detail/trypanosomiasis-human-african(sleepingsickness)#:~:text=Human%20African%20trypanosomiasis%2C%20also%20known,from%20infected%20human. Accessed 10th September, 2023.

Wossen, T., Alene, A., Abdoulaye, T., Feleke, S., Rabbi, F., & Manyong, V. (2021). Productivity and welfare effects of agricultural technology adoption: Evidence from Nigeria. *World Development, 137*, 105–120.