



Tsetse and trypanosomosis associated socio-economics and environmental variables limiting livestock and dairy development in northern parts of Edo State, Nigeria

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ABSTRACT

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Edo North is in a low-lying plain with hilly terrain rising up to 672 meters above sea level in some area. It has good vegetation cover, forest reserves, network of perennial rivers and streams and favourable eco-climatic conditions ideal for tsetse breeding. Both primary and secondary socioeconomics, environmental and ecological-health derived data were subjected to descriptive and percentage statistical analyses. Interactive meetings were held with key informants (n=38); Local Government officials, community leaders and representatives of Fulani pan sociocultural group in Edo North were interviewed and administered questionnaire. Focus group discussions were held with herders (n=85) and natives (n=350) who freely participated. The huge livestock and dairy production potential of the study area are due to availability of natural forage, crop fodders, agro-based byproducts, and water all year round. Most herders (80%) and natives (60%) have good knowledge of the disease and vector, but only a few (10%) knows the mechanism of transmission. Prevailing mistrust and widespread apprehension over herders-farmers' clashes and other criminalities were attributed to itinerant nomadic Fulani by majority opinions. Lack of access to grazing lands, perceived poor rate of returns using planted fodder and feed concentrates were viewed as uneconomic compared to traditional free range grazing. Most pastoralists believed that government support to livestock sub-sector is ridiculously low compared to crop commodities. The dire need to address the thematic areas that can strongly impact on job, wealth creation, means of livelihood, and substantially facilitate economic diversification drive cannot be overemphasized.

Contribution/Originality: Biting flies, trypanosomosis and theory of change (ToC) remained critical factors to intensive livestock management and dairy value chain development in sub-Saharan Africa. Low meat and milk protein production and consumption persist because huge natural resources conferring opportunities for attaining some targets of sustainable development goals (SDGs) have remained untapped.

1. INTRODUCTION

One of the main handicaps for the development of livestock farming in the humid and sub-humid zones of the continent is African animal trypanosomosis (AAT) [1]. Trypanosomes are the cause of trypanosomosis, and is transmitted cyclically via bites by different tsetse fly (*Glossina species*) and mechanically by haematophagous biting flies [2]. Transmission to man and animals takes place mostly in rural areas where agricultural related activities expose them to the bites of tsetse fly. The common tsetse fly-transmitted animal infective trypanosomes are *Trypanosoma brucei brucei*, *T. congolense* and *T. vivax* are responsible for barring livestock from large areas of land capable of supporting cattle and other ruminants [3]. Other biting flies are mechanical transmitters of *T. vivax* and *T. evansi* the cause of surra or derrengadera or “mal de cadeiras”, while *T. equiperdum* is the aetiology of duorin or “mal du coit”, which occurs as venereal transmission in horses, camels and donkeys [4] are widely distributed in almost all the continents. Tsetse and animal trypanosomosis (TAT) impact negatively on agriculture that accounted for 24.4% of gross domestic product (GDP) with a range between 20-30% while 90% of cattle and its by-products come mostly from pastoralists (herdsmen/herd owners) contributes between 6% and 8% to gross national product (GNP) [5]. Nigeria's 0.6 million tons of milk production only covers 40 percent of the demand [6] is among the lowest in the world. Most dairy processors import and reconstitute imported milk powder into liquid milk and other dairy products like yoghurt, ice cream and confectioneries. Nigeria's meat consumption of 0.1 Kg/day is by far less than the FAO recommended 0.35 Kg/day or 7.0 Kg/year. On the other hand, total milk consumption of Nigeria is less than 10 L as against 28 L for Africa and the global average of 40L per head. In those parts of Nigeria where the tradition of milk consumption is well entrenched, an average of 50 L per year is consumed by a Fulani person each year. Across the whole of the country, the annual average ranges around 20 L which is four times and twice less than global and EU standards [7]. The number of pastoralists in sub-Saharan Africa has been estimated to be more than 50 million. Hausa/Fulani herders account for over 90% of the cattle population, whereas more than 30 percent of live animals slaughtered in Nigeria are from neighbouring countries [5]. Friesland Campina (FC) and West African Milk Company (WAMCO) partnership supports government efforts to replace imports with domestic milk production. This has brought Fulani pastoralists as well as ‘sedentary’ smallholder farmers into dairy markets many for the first time [8]. Edo State is one of the 10 selected frontline states (Adamawa, Benue, Ebonyi, Edo, Kaduna, Nassawa, Oyo, Plateau, Taraba, and Zamfara) to receive intervention in form of ranches [9]. The funding by both the Federal and State Governments for the first 3 years was put at ₦70 billion whereas private sector was expected to fund between a third and for ten year with more than ₦100 billion. This programme, like many other good and well intentioned ones, may go the same way like others that have gone oblivion due to abysmal failure as a result of poor implementation management and were marked with inefficiencies, lack of financial prudence, transparency and accountability. Non-involvement of grassroots stakeholders is always the reason d'état for lack of sustainability of laudable past intervention projects.

This study interrogated the natural resources, which included land, environmental and human capital suitable for intensification of integrated mixed crop-livestock farming, and prevailing socio-economic variables. This project is aimed at assessing the presence or absence of favourable climatic conditions, availability of water and forage, adequate manpower needed to be engaged, and the atmosphere conducive to carry-on livestock production and dairy processing in the study area. To assess the extent the livestock development project can engender in attaining some of the targets of the sustainable development goals (SDGs): particularly poverty alleviation, gender inclusiveness and sustainable job and wealth creation, and improved agricultural practices through strategic TAT control. The failure of past and current stalemate over the livestock development projects and the growing youth restiveness can be remedied by optimally exploiting the potential of this derived Guinea Savannah-mosaics ecological zone. A paradigm shift from nomadic pastoralism dominated by Fulani tribe is a hard kernel to crack before the livestock subsector can be modernized as other tribes view it from this narrow prism. It will require

applying theory of change (ToC) to facilitate the actualization of livestock and dairy value chain for increased meat and milk protein production and consumption.

1.1. Purpose of the Study

The objectives of this study were to obtain data and baseline information from pastoralists, natives and key informants. To assess how livestock production is influenced by the level of herders' knowledge, attitude, belief, and perception (KABP) about the vector and disease in the study area. To obtain information on how herders' and natives are predisposed towards diagnosis and treatment of animal and human African trypanosomiasis (AAT) and (HAT), and how they approach the control and management of the vector and disease. To investigate how the vector and disease impacted on livestock productivity in terms of meat and milk protein quality and quantity, hide and skin. Undertake feasibility of promoting livestock and dairy value chains within the study area. Take inventory of the biotic and abiotic environmental and natural resources that could support or hinder the attainment of the stated objectives *vide supra*.

2. MATERIALS AND METHODS

2.1. Study Areas

The study was carried out in the Six (6) local government areas (LGAs) in Edo North Senatorial District (ENSD) of Edo State, which occupies latitudes $5^{\circ}44'N$ and $7^{\circ}37'N$ and longitudes $5^{\circ}44'E$ and $6^{\circ}43'E$ [10]. The Edo North is marked by southern limit of latitude $6^{\circ} 52'N$ with a grid reference of 223000N, 182000E [11] is in the South South Geopolitical of Zone of Nigeria. The rainfall amount in Edo North ranges from 1500mm – 2200mm. The villages and local government areas (LGAs) are Owan East, Owan West, Etsako West, Etsako Central, Etsako East, and Akoko Edo as shown on Figure 1. The team visited herders in three (3) LGAs of Owan East, Owan West and Etsako West and 8 communities, namely: Otuo, Olum, Ikhin and Ake in Owan East LGA, and Ikepyam, Oromen/Okeigbo, Iloje and Eruere-Oshokfo in Owan west LGAs of Edo State, Nigeria. Edo north has a total land mass of 827.93 km² and a population of 1,272,100 based on the NPC [12] census projection using 3% growth rate.

2.2. Method and Source of Data Collection

Questionnaires were prepared and distributed to key informants in the six LGAs who filled and returned same. Question lines were developed and used for focus group discussions (FGD) that were held with 5-9 participating pastoralists per session. The question lines were categorized into two broad objectives: (i) to assess the knowledge, attitude, perception, and believes (KAPB) of the herders as well as to understand the cultural taboos that may influence these variables. (ii) To study the treatment seeking behaviour of the livestock owners or herdsmen, identify the herd management system in operation, and to enlighten them on the need for a change from the old system to modern animal husbandry management practices.

2.3. Study Objectives

Six specific objectives of the study are: (i) to assess the influence of education status on knowledge and awareness about tsetse fly (*Glossina species*) and the disease; animal African trypanosomiasis (AAT). (ii) How the herders view the vector and disease from animal health angle was graded as non-serious (0) or absence, to slightly, (1), moderately (2), highly (3), and very serious (4). (iii) To identify animal management practice that exposes and predisposes animals to the vectors and disease, respectively. (iv.) To assess respondents' believe and perception about the disease, transmission agent or the mode of transmission. (v) To enquire how livestock owners/herdsmen seek treatment of animals, and (vi) what are the cultural, environmental, social and economic factors that influence status of tsetse and animal trypanosomiasis (TAT) in the study area. We relied on physical observations and derived

secondary data on environment, vegetation, road network, river systems, animal and human population based on 2006 projected census figures adjusted using 3% growth rate.

A total of 37 question lines comprising closed ended (n=32) and open ended (n=5) questions that required further probing or detail explanation were asked during FGD interactive sections. The FGD was conducted by one interviewer assisted by two persons that took down notes and made audio recording. An interpreter who understands Hausa and English was relied upon to translate and enhance communication between the team and the herders, where necessary.

3. RESULTS AND DISCUSSION

3.1. Outcome of Interactive Meetings and Questionnaire Survey

In addition to the core study undertaken, concerted efforts were made to mobilize, sensitize and raise the consciousness-and create awareness about the disease, the vectors, available control options, inherent and apparent socio-economics implications in the study locations. Discussions and interactive meetings were held with the designated number of officials shown on Table 1. It was only in Etsako West the Chairperson was on seat and was engaged with people from two feuding communities in dispute over farm land that had led to violent clash with resultant loss of lives (one on both sides). This event influenced the highest number of LGA officials that turned out to attend the interactive meeting. This singular communal conflict was an ominous indicator the role land disputes play in precipitating conflicts across the country, which is not restricted to herder-farmer contention alone. Communal land dispute is not uncommon feature in this area and sometimes there are old unresolved disputes over farm lands and boundary claims. The low attendance by Owan East LGA was due to an early engagement with some officials: the Secretary who stood in for the Chairman and 4 others.

Table 1. Personalities that participated in the interactive discussion meetings.

S/No.	Local govt. area	Participants	Sample size (n)
1.	Ako Edo	Head of service (HoS), vice chairman (VC), head of department (HOD) of health, and veterinary and onchocerciasis control officer (OCO).	5
2.	Etsako Central	The VC, 2 HODs; health and agriculture, and five other staff.	8
3.	Etsako East	HoS, 2 HODs Health and agriculture and 7 others staff.	10
4.	Etsako West	HoS, 2 HODs; Health and agriculture and two other staff.	5
5.	Owan East	The VC, Vet Dr., chief nursing officer.	3
6.	Owan West	HoS, VC, 3 HODs, special assistant, and 3 other staff).	9
7.	Total	HoS (n=4), V. Chairman (n=4), HODs (n=11), and other staff (n=21)	40

3.2. Assessment of Response by LGAs Officials

Officials of Owan West, Owan East and Etsako Central whole heartedly welcomed the project and expressed willingness to participate. The Owan West officials were particularly very ready to get into partnership with the institute in livestock rearing in tsetse infested area. On matters like this, which offers ample opportunities for partnership if not immediately utilized and concretized becomes practically difficult when there is a change in governance hierarchy. Officials of Etsako Central were excited that the already existing active female/gender involvement in cattle breeding by Anegbete and Udochi women will be a good starting point. The communities are said to be rearing indigenous cattle breed described to be West African dwarf (WAD), with shorthorns and humpless feature that fits the N'Dama, Muturu or Keteku breeds. According to Roberts and Gray [13] the N'Dama (*Bos taurus primigenus*) are less affected by trypanosome infections compared to Lagune or Muturu (*Bos taurus brachycerus*) and Zebu (*Bos taurus indicus*) that were moderately and more severely affected. These breeds have potential values

than others that could be used to greater extent in livestock development in tsetse-infested areas of West and Central Africa than it was being used. The same situation still exists within the study area.

The readiness and strong commitment by the LGAs to key into the project were overwhelmingly expressed. Only Etsako East officials were somehow hesitant about the youths resentment; who may not be interested in agriculture because of the hardship it entails making it socio-economically unattractive business. Sequel to our discussion, officials of the LGAs saw the benefits derivable from mixed crop-livestock farming as means to job and wealth creation particularly harnessing the potential of Edo north and Edo State. There are vast arable lands, natural forage and crop fodders from various crop farming activities. In addition, the area is endowed with numerous perennial rivers and streams that guaranteed availability of water all year round. The major rivers are Orle, Owan, and Edion, Osse, Obe, Ube and the River Niger. The River Niger bound Edo State in the east and shares border with Kogi State as shown on Figure 1. The herders (n=85) in 10 settlements; 3 locations at Agor and one each at Ikhin, Otuo, Uwuake and Iyhiku in Owan East; Sabon Gidan Ora, and Ebira Camp at Auchi in Etsako West were visited.

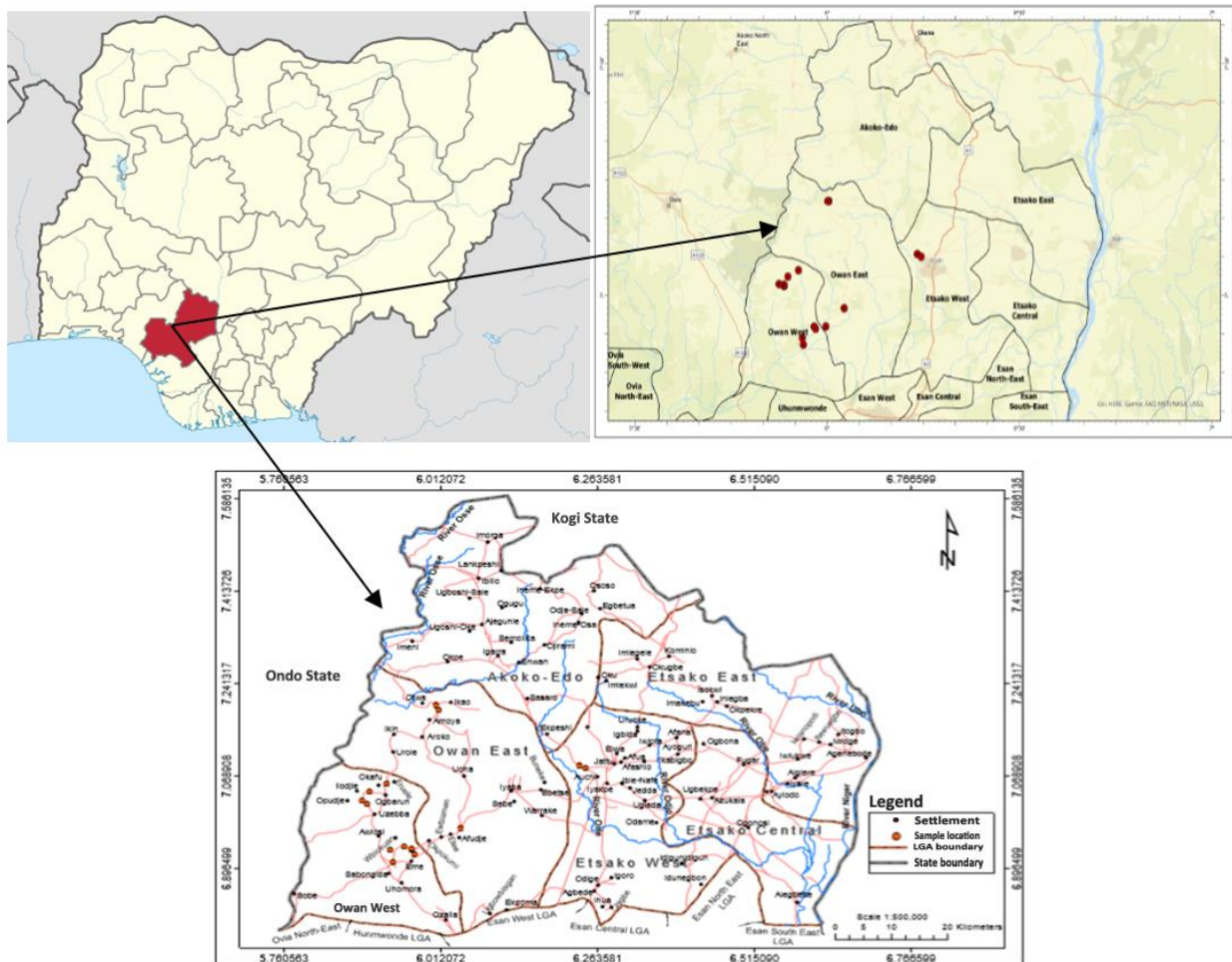


Figure 1. Map of Nigeria showing insert map of Edo State above (a) The maps of Edo North Senatorial Districts showing (b) River system and study locations and (c) Network of interlinking roads and communities.

3.3. Effects of Dynamic Biotic Factors on Sustainable Tsetse and Trypanosomosis Control

Consequent to massive logging and bush clearing for agricultural and other developmental purposes, hunting and poaching of wild animals have upturned rainforest ecology that used to be haven for dense flora and fauna comprising elephants (*Locotonda Africana*), lions (*Panthera leo*), tigers (*Panthera tigris*), buffaloes (*Bubalus bubalis*), Hartbees (*Alcelaphus buselaphus*), bushbucks (*Tragelaphus scriptus*), etc. Both the dense vegetation and large number of

wild life have been drastically reduced and eliminated, respectively. Jordan [14] had reported the main sources of blood meals in studies carried out at Ugbobigan now in Owan East LGA of Edo State were man (*Homo sapiens*), reptiles, bushbuck (*Tragelaphus scriptus*), red river-hog (*Potamochoerus porcus*), porcupine (*Hystrix cristata*), bovidae and buffalo (*Syncerus nanus*). According to the key informant narrative and the herders account, only few wild animals like antelopes (*Hippotragus equinus*), warthog (*Phacochoerus africana*), grass-cutters (*Thryonomys swinderianus*), reptiles such as snakes including Boa constrictors (*Boa constrictors*), monitor lizards (*Varanus indicus* and crocodiles (*Crocodylus acutus*), and monkeys (*Simiiformes platyrrhini* or *S. catarrhini*), etc. are now found in this area. For many decades, the area had witnessed continuous movement of Fulani cattle herds in and out in droves. The cows would serve as source of blood meal for the flies' survival, thereby influencing the disease endemicity and transmission dynamics.

Being traditionally agrarian communities, the rate of man-fly contact generally rated very high by all the communities visited with many people remembering been bitten once or more times in their life with increased frequency of tsetse bites higher in older age group. All the communities claimed that flies are found in homestead and inside houses particularly more intense during raining season when very painful tsetse biting menace occur more often. The need to undertake an HAT screening/diagnostic and entomological surveys to determine the current epidemiological status should be of importance to determine if there is active transmission. In view of the global declaration on HAT, it has been projected for eradication by the year 2025. An intervention directed at addressing both animal and human disease under one-health strategic approach will no doubt provide a higher benefit-cost ratio (BCR).

From among the many herders participating in the annual seasonal migration to and from, north and south of Nigeria have decided to practice sedentary or transhumant lifestyle. Up to 30% representing the young herders who claimed to have been born in this area, whereas 60% of the herders have resided in the area for 20 years or more. There have been reported cases of trypanosome infections in Anurans like frogs and toads [15]. *Trypanosoma spp.* has been reported in frogs (*Amietophrynus regularis* and *A. maculatus*) collected from Agenegbode and Usen, respectively in Edo State [15] and in frog (*Rana temporaria*) from Ibadan in Oyo State, Nigeria by Omonona and Ekpenko [16]. This will certainly have important influence on the disease endemicity and epidemiology. A study undertaken at the Cattle Ranch in Igarra, Akoko Edo LGA from 1998 to 2002 by Owai [17] showed prevalence of helminthiasis 31.6%, ectoparasitism 37.3%, typanosomosis 18.6%, pneumonia 7.2%, rinderpest 3.2%, and Foot and Mouth disease 2.2% in bovine. These diseases were also reported at lower prevalence among the caprine and ovine breeds in the ranch.

3.4. Socioeconomic Implication of Resident and Migratory Pastoralist

Attempt to get the migrant pastoralists to participate proved very difficult. It is assumed that this project may likely attract some nomadic herders to settle down and leverage on the advantage of the dairy business opportunity, the infrastructural and veterinary incentives that goes with it. Majority of settled herders are also engaged in one form of crop farming in maize, sorghum, plantain/banana and yam within the vicinities of their homestead. There are instances where the *Ruga* eventually evolved as the nucleus of a new farm and human settlements. The basic socioeconomic niceties of herders are: they lived in thatched huts, no source of potable water, and no access to any other public utilities (light, school, primary healthcare Centre, veterinary clinic, etc.). One endearing attraction of most *Ruga* settlements visited is the exquisite cleanness of the living area. Against all odds, it is a failure on the part of governments over many decades of lack lust attention giving to livestock sub-sector. Allowing them to continue living in this precarious condition is tantamount to disservice and outright lack of sincerity in policy implementation and implantation that failed to translate and transform the livestock subsector to attain the desired goal within the framework of National Livestock Development Programme. For many years, the land use pattern in Edo north has remained unchanged as observed by Forest Monitoring and Evaluation Coordination Unit

(FORMECU) [18] that is why livestock production has become increasing important, nonetheless, it is still of minor importance compared to agriculture in this area. In the northwest, grassy uplands allow permanent grazing sites for the cattle belonging to Fulani pastoralists. Livestock production is mainly village-based, where WAD goats (*Capra hircus*) and sheep (*Ovis aries*), and pigs (*Suis spp*) are the main species raised. Dairy potential of the WAD goats majorly owned by women in West Africa [19] has to be maximally exploited along with dairy cows.

3.5. *Apprehension and Mistrust Expressed by Participants*

The majority of the officials were afraid that their people may misconstrue the project to be an attempt to foster and introduce the Fulani herder into their lands and territories. The increasing wave of herders–farmers’ clashes were recalled to be worrisome development that may militate against its wide acceptance. Moreover, cases of rapes, killings, robberies and attacks have been placed on the door steps of the Fulani herders. These issues will no doubt jeopardize the establishment of milk collection and bulking centers, and full complement of the livestock and dairy production, management, marketing and processing value chain. The fears expressed are justified going by the adverse effects of farmers/herders’ clashes resulting in loss of human and animal lives; destruction of crops; reprisal attack, loss of innocent souls; displacement of persons and animals; and distrust between herdsman and farmers [20]. A holistic approach to conflict management through strategic planning is needed now than ever to drastically resolve and reduce to barest minimum by addressing all possible underlying causes of conflicts. Edo North is relatively low in the occurrence of insecurity as observed from 2012–2015 citing political and cult violence, cases of armed robbery, and kidnapping compared to national data.

Poor performance and inadequate number of institutions charged with the mandate of livestock development and failure of governance to fulfill the aspirations of citizens’ livelihood are the bane of the current situation that started many decades ago. The climate change has also contributed to a large extent in exacerbating the man-made damage from excessive depletion of natural resources with impunity. It has been recognized that the distribution and prevalence of vector-borne diseases may be the most significant effects of climate change [21]. Enhancing the adaptive mechanisms of African livestock owners to cope with animal health problems will require appropriate policy and institutional support.

3.6. *Youth Resentment of Agro-Business*

Most key informants opined the existing vogue among a large population of youths shunning and detesting agriculture related business as unattractive and not profitable. After exchange of ideas, it was generally agreed that some youths may be convinced through well-articulated advocacy and sensitization workshops could influence change in mindsets and their *a priori* believes. Involvement of all relevant stakeholders at LGA, State and Federal Ministries, Departments and Agencies (MDA) have very crucial roles to play in appealing to the large numbers of unemployed educated youths to seize the unique opportunities offered by the project to have a rethink. With a fundamental tension between business incentives and vector control, Bardosh [22] demonstrated how divergent in knowledge, power, values, and social norms shaped project implementation and community responses.

The immutable roles of the local and state government to buy-into the project was identified by majority of Key informants and pastoralist, as a sure means to encourage the youths and other interested target stakeholders in developing interest and willingness to actively participate. In reviewing the potential benefits offered by the project, milk production and dairy products value chain by small scale livestock farming could serve as nucleus for establishing dairy clusters within the six LGAs of ENSD in particular and Edo State and the South-South Geopolitical Zone in general. Similar to the proposed ranch models under the National Livestock Development Programme (NLDP) suggesting clusters of 30, 60, 150 and 300 cows per ranch in a location within the donated reserve, as well as a minimum of 1000 cows breeder ranch in 7 of the 10 Pilot State [9]. Alternatively, a cluster of

farmers with a multiple of 2 cross-bred (local and exotic) dairy cows per hectare could be adapted as a model to engage stakeholders in mixed crop-livestock farming in tsetse infested and animal trypanosomosis endemic area.

3.7. Awareness Creation and Enlightenment of Participants

After each FGD with the herders and the members of the communities, a brief session of enlightenment and awareness creation were conducted in 10 locations with display of canvass posters at Owan East (Ojavho, Ikhin, Ake, Otuo and Uwuake), Owan West (Sabon Gidan Ora) and in Etsako West (Ebira Camp at Auchi) for pastoralist. Both direct and indirect impact of TAT was briefly explained to both key informants and the herders, a general consensus was formed. Every participant recognized that a remarkable improvement in meat and milk production can be achieved in the ENSD if TAT constraints are mitigated. Important direct impact of the disease is attributed to stock mortality and depressed productivity in meat, milk, reproduction or traction [23]. On the other hand, it indirectly impacted on agriculture and the livelihood of rural population, influence on settlement, and how they manage their livestock, and reduced intensity and mixed crop agriculture practice. All these negative effects on cattle herds and socio-economic implications are in fact very glaring and prevailing situation in the study area.

3.8. Secondary Derived Environmental Data

Some of the derived data on environmental conditions show that dry season in Edo State usually commences from early November to late March as the rainy season start from late March to early November [10]. The ENSD is situated in low-lying plain and has a plateau that ranges from 183-305 metres of basement rock with occasional granite peaks rising above 610 m. The Afemai hills rise to a height of 672 m above sea level. Edo North lies between longitude 6.02° – 6.69° and latitude 6.80° – 7.11°. The amount of rainfall in Edo North ranges from 1500mm – 2200mm [24]. The area is endowed with good vegetation, forest reserves and good climatic condition. The area has been described as derived savannah-mosaic zone of northern Edo State [25]. The monthly relative humidity was 83.23± as at 0900 GMT based on Meteorological Department of Federal Aviation Authority of Nigeria (FAAN), Benin as cited by *Edo State Statistical Year Book (EDSYB)* [10]. An average annual ambient temperature is about 32.03°C with a range of high, 35 °C and low 18 °C. Average humidity was 33% ranged from high, 75% and low, 15%. A total of 51,990 hectares of forest reserves spread in five LGAs vary in size are under threat. According to *FAO* [26] Nigeria is among the five countries with the largest annual net loss of forest between the periods of 2005 to 2010, about 410,100 hectares representing 55.7% of its primary forest [27].

There is no forest reserve in Akoko Edo, with Etsako Central having the least, 6000 ha, then Etsako East 7000 ha, Owan East 12,422 ha, Etsako West 13,102 ha, and Owan West with 13376 ha has the largest. All the forest reserves have continuous natural vegetation cover and the existing number of river, rivulets and streams provide river-forest galleries, the ecological niches are ideal high tsetse suitability index (TSI). Application of spatial autologistic regression model (SARM) showed that the probability of tsetse presence increased with the proportion of forest cover and riverine vegetation [28]. Orle River is about 100 km long and takes its root from Akoko Edo running through Etsako West through the entire Edo north before terminating into River Niger at Anagbete [24]. Far reaching entomological implication of all these are that the tsetse breeding sites are targeted locations for control preferably during the peak period of the dry season that last between November and late March. This is when tsetse activities are confined to cooler and shaded water grooves by prevailing high environmental temperature and dryness, coupled with intense incidence solar rays (ISR), which are existential threat to adult tsetse. It is a well-established fact that extreme high ISR is very critical and have negative impact, causing mortality of both the pupa and adult live stages of tsetse [29]. Going by this parameter, it can be adduced that large number of screens and targets will be needed for deployment to achieve effective coverage and adequate trap density to attain high performance efficiency. Similarly, it was clear that the forest reserves were under threat from massive logging for timber and encroachment by farmers who cleared the trees from the rich fertile lands to meet

the high demand for crop farming, which is a negative consequence of increasing human population. Existing secondary forest could be explored for sylvopastoral farming. Secondly, the areas harboured wild or game animals which served as source of blood meal for tsetse flies and also as reservoir host for trypanosomiasis. Hence, the threat posed by the forest reserves will require the creation of barriers with insecticide impregnated screens and targets to protect any livestock development within adjoining forest reserves.

3.9. Reservations about Developing Dairy Value Chain

Overriding the assumptions about threat from Fulani presence in the area did not diminish the enthusiasm among the estimated population of herders in the LGAs. This will no doubt bring to bear on the proposed milk production and dairy value chain involving the pastoralists. Added to this, is the feasibility of developing smaller holder dairy cattle breeders involved in mixed crop-livestock farming scheme to be introduced. Therefore, going by the data on herd size put at between 50-150 with a mean plus or minus standard deviation of 121 ± 5.5 cattle, it was conservatively estimated to have between 5-10 herds within about 5 – 10 grazing locations per LGA. Overall, herders estimated cattle population in Edo north ranged between 25,000 to 30,000 cows. Livestock population as at 2015 was 17,300 cows (*Bos taurus*), 9800 sheep (*Ovis aries*), 16100 goats (*Capra hircus*), and 160 pigs based on [10]. An average daily milk production per cow was generally less than 2 litres and 213 L per year is far less than one tenth of the global average [30]. There is no doubt that the quantity can be increased to 5 litres with feed and concentrate, and reduced stress from trekking [9]. Drastic reduction in both milk quantity and quality are direct serious negative impact attributed to AAT in the area. It was suggested by many respondents (n=60) that even the disease could result in non-production of milk by infected cow. These qualitative and quantitative data (number of cows and daily milk outputs per cow) provided by herders are used to project the amount of daily collectable milk from pastoralists could reach 10,380-12,000 litres at inception. This projection was based on the assumption that 40 percent of cows will be lactating per annum. It is plausible to attain daily collectable raw milk up to 14,000 litres within 3 years as observed in Oyo State dairy development project (DDP) operational area. This goal can be achieved based on the following assumptions: possible increase in the numbers of herders who decided to embrace sedentary practice, change in animal husbandry management system to include use of feed supplement, concentrate, green fodders, and control of TAT within the study area [8]. In addition, if the cluster of Smallholder Dairy Cow (SDC) comes on stream, it could boost milk production remarkably. Worthy of note is the fact that the leadership of the foremost livestock group, the Miyetti Allah Cattle Breeders Association, (MACBAN) in ENSD and most herders expressed enthusiasm, willingness and readiness to actively participate in the milk collection process.

3.10. Logistic of Milk Collection Programme

Among the critical requirement for conveying milk in standardized aluminum cans from Ruga with motorbikes and vehicles to any of the 3-6 proposed milk collection centres (MCC) and one milk bulking centres (MBC) was proposed. Movement between any two of the six LGAs can be accessed in one hour from Auchi to Agenegbode or Owan West LGAs with Etsako Central and Owan East in between them, respectively. Ako Edo is also less than an hour drive from Auchi and easily accessible to Owan East or West. Traditional Fulani settlement is called “Ruga” in Fulfulde and also an acronym for the controversial programme of “Rural Grazing Area” (RUGA) are often located inside bushes where milking takes place in the morning. An example of a typical traditional Ruga is shown on Figure 2. Conveying milk from different settlements is central to the proposed local sourcing of milk from settled Fulani pastoralists and a job creation for indigenes as observed in Oyo and Kano States [31]. The significant difference in milk income between the two states was due to the fact that the unit price for milk was higher in Kano than in Oyo. Dairy production can be scaled up by creating clusters of small-holding dairy cow farms with capacity and capability to facilitate the deployment and adaption of modern livestock biotechnologies such as *in vitro* fertilization (IVF), artificial insemination (AI), oestrus synchronization (OS), and embryo cloning among others

[32]. All these techniques can be transferred to youths along with other intensive livestock management systems detested by the older nomadic herders. As noted by Sahel Consulting Agriculture and Nutrition Limited [31] practical lessons can be learnt from the smallholder Kenya dairy farmers who are settled, owned 2-5 crossbreeds, which contain up to 95% genetic component of exotic breeds and also engage in crop farming. Whereas the medium to large scale farmers own 5 – 10 or more cows, mostly all exotic breeds, and focused mainly on dairy farming.



Figure 2. (a & b): A typical Fulani settlement called “Ruga” in Fulfulde. (a) Newly constructed and unoccupied hut. (b) A view of “Ruga” located in Owan East LGA of Edo State.

3.11. Socio-Demographic Characteristics of the Respondents

The educational status of herders was assessed and found that majority were not literate by western standard as observed by Osue [29]. Table 2 shows that 48 (56.4%) of the 85 respondents have no formal education and 2.4% with post-secondary school education reflected the knowledge gap required to translate into modern livestock management systems. There was strong association of the high number of persons with no formal education and the preferences for seeking professional treatment of animal African trypanosomosis. After three decades when the National Nomadic Education Commission (NNEC) was established in 1990 and charged with the mandate to provide primary education for children of nomadic pastoralists. This seems to have made the desired impact on the herders educational attainment with over 37 (46.6%) having at least a basic primary education.

Among the native respondents (n=350) interviewed, the male and female respondents were 223 (63.71%) and 127 (36.29%), respectively. The highest percentage of age brackets was 46-55 with 117 (33.43%) followed by 36-45 year with 95 (27.14%). Other age groups were 20-25 year, 40 (12.86%); 26-35 year, 64 (18.86%); and 56 years and above were 34 (9.71%). A total of 210 (60.00%) had secondary education; 99(28.29%) had Diploma/its equivalent; 30 (8.57%) were B.Sc. degree/higher national diploma (HND) graduates; 11 (3.14%) respondents were postgraduate degree holders. This caliber of youths and population in general should be empowered and mobilized to take up livestock and dairy production and to explore and exploit job and wealth creation from the value chain for meaningful livelihood.

Table 2. Level of respondents’ educational attainment.

S/No.	Level of education	No. of herdsmen	%	No. of natives	%
1.	No formal education	48	56.4	0	0
2.	Primary	17	2.0	0	0
3.	Lower secondary	10	11.7	0	0
4.	Higher secondary	8	9.4	210	60
5.	Post-secondary	2	2.4	129	36.9
6.	Postgraduate	0	0	11	3.1

3.12. Years of Experience in Cattle Rearing

Livestock rearing is regarded as traditional occupation, way of life and means of livelihood of Fulani in Nigeria and 14 other countries in West and Central Africa. In Table 3 shows those with the years of experience in cattle rearing of 11 – 20 years and 21 – 30 years are 32.9% and 50.5% of the herders, respectively. The larger percentage of herders is in their youthful years due to the rigor of nomadic lifestyle adopted to cater for their livestock. Those below 10 years and 41 years and above had the lowest percentage of 4.7% and 5.8%, respectively, which actually proves that young and middle aged men are more actively involved in cattle herding and rearing activities. Elderly men are pre-occupied with family affairs to provide food and care of the children when the women have gone out to hawk their milk. Therefore, it is necessary to improve research extension activities amongst pastoralists to create awareness about the vector and the disease. The herders demonstrated that insecticidal vector control could target two or more vector-borne diseases and assuage fly biting menace.

Table 3. Years of involvement in livestock rearing.

S/No.	Years involved	Respondents	Percentage
1.	≤10 Years	4	4.7%
2.	11 – 20 Years	28	32.9%
3.	21 – 30 Years	43	50.5%
4.	31 – 40 Years	5	5.8%
5.	41 – Above	5	5.8%

3.13. Livestock Management Practice

The indigenous people undertake mainly agrarian activities of crop farming, which is often combined with hunting, lumber-jacking, trading, teaching, commercial motorbike, and LGA employment. Another pre-occupational engagement of the herders in maize and sorghum farming, with 94% of the respondents were livestock farmers while traders accounted for 6%. Among the crops farmed by the indigenes are cassava, yam, corn or maize, plantain, banana, groundnut, sorghum, etc. They also farm cash crops like cocoa, cashew, oil palm, citrus, sugar cane, and kolanut in decreasing order of relative importance accorded each crop commodities. At the same time, some indigenous people also keep few numbers of WAD sheep and goats under free range browsing and scavenging for domestic wastes within homestead and into nearby adjoining bushes.

To fully develop the livestock sub-sector will depend on Government agencies providing necessary infrastructure, tsetse fly control, and breed improvement. Other technical partners are to provide chilling equipment, feed, seeds (forage, crops, and cross-bred animals) and veterinary services. On both global and local outlooks, livestock is administratively restricted to the purview of the agriculture sector. But from the operational reality and exigency, it derived some essential inputs from wide perspective of multi-disciplinary, multi-sectorial and to certain extent, multilateral stakeholders' cooperation and participation. Current slaughter weight of beef cattle is 250 kg/head against a potential weight of 400 kg/head. The estimated milk yields is less than 2L against a potential of 5L for local breeds and between 10-15L for improved cross-breeds as recently reported by Bunja, et al. [33]. Exotic breeds are not suited to climatic condition in Sub-Saharan Africa and they are highly susceptible to prevalent endemic diseases particularly AAT. International bilateral assistance will be required to introduce genes of exotic breeds to improve better performance in terms of beef production by selecting for breed with high meat carcass weight or trade livestock unit (TLU) especially traits of high conception rate (cow) and good feed conversion rate (feed/gain), and for high milk yield for dairy production using embryo transfer technology [34]. This is where collaboration with foreign laboratories specialized in in vitro fertilization, IVF embryos which are classified according to the criteria set by the International Embryo Technology Society should be engaged through bilateral cooperation. In so far genetic resources of indigenous breeds are protected in strict compliance and conformity with the National Biosafety Guidelines for the use of genetically modified organisms (GMO).

3.14. Forward Looking Strategic Plan of Actionable Events

It will be very worthwhile to encourage actionable scaling up the breeding and cross-breeding of indigenous dwarf cattle, sheep and goats with exotic breed to harness their phenotypic meat carcass quality, high milk production and ability to withstand trypanosome infections termed trypanotolerant or trypanoresistance traits by Roberts and Gray [13]; Annatte [7]. This should be explored as veritable means in promoting the livelihood of the people, job and wealth creation for the teaming youths and other interested persons especially retirees desirous to engage in post-retirement agribusiness. More importantly, it provides strong opportunities for economic diversification, increased internal revenue generation (IGR) with great potentialities for shoring up the economy of the state thereby contributing to increased gross domestic product (GDP). It was obvious that the Fulani pastoralists managed their livestock extensively as a prescribed or inherited age old practice. Most of the pastoralists respondents 80 (94%) do not confine their livestock. This is one reason animal African trypanosomosis has proved difficult for control because livestock are routinely moved from very safe tsetse free area to vectors (tsetse and biting flies) infested high risk areas for grazing due to difference in comparative advantages. Only 1.1% practice intensive management, 4.7% semi-extensive management and 94.2% extensive management of livestock. Intensive management is not a popular practice among the majority of Fulani pastoralists because it entails spending money to procure animal feeds and concentrates. It was argued that cost of feeding small and medium-holding with ≤ 20 cattle/herd and 21-50 cattle/herd, respectively are different from large-holding of ≥ 50 cattle/herd. Be that as it may, the idea of growing pasture was vehemently detested because they believe it is time wasting, expensive and assumed to be highly uneconomic. With 80% of 3 million dairy cows in Kenya owned by small-scale farmers and majority is confined to zero grazing receive trypanocidal drugs (diminazene aceturate for therapy or isometamidium chloride for prophylaxis [35] still experience trypanosomosis causing adults mortalities, abortions, stillbirths and a reduction of milk production). Insecticide-treated netting significantly reduced the risk of trypanosome infection in cattle and significantly increased the mean haematocrit (from 27.6 ± 0.6 to 29.7 ± 0.4 ; $P < 0.05$). A combination of both case detection and treatment with vector control will be the optimal strategic tsetse and trypanosomosis control and management.

3.15. Relevant Stakeholder Institutions and Development Partners

In addressing some crucial issues that arose from interactive meetings, FGDs and interviews are questions begging for answers: who provides the fast growing forage seeds, the land for ranch, who conducts the technical training for herders on fodder development and hygienic milk processing. A readily thinkable answer to these identified challenges is simply to replicate similar strategies that have been tested, proven attainable and adaptable elsewhere. A concerted and collaborative private public partnership to provide the much needed intervention supports becomes expedient. It is worth drawing from the practical experience from the FC/WAMCO DDP operational area in Oyo, MILKOPA in Abuja and L&Z Dairy Company in Kano and Abuja through tactfully managed off-taker arrangements. The Federal Ministries of Agriculture and Rural Development (FMARD) and Water Resources (FMWR), NITR, National Animal Production Research Institute (NAPRI), National Veterinary Research Institute (NVRI), and NLDP should be actively involved to discharge their various responsibilities. Other relevant government stakeholders with specific functions that should to be fully involved are: Nigeria Nomadic Education Commission (NNEC), Central Bank of Nigeria (CBN), Bank of Agriculture (BOA), and the Nigeria Incentive-Based Risk Sharing system for Agriculture (NIRSAL). Among the international non-governmental development organizations (NGDOs) and donor partners include the United Nation's Food and Agricultural Organization (FAO), International Fund for Agricultural Development (IFAD), British Government Department of Fund for International Development (DFID), World Bank (WB), African Development Bank (ADB), and many other friendly development partners to mention but a few.

The key areas requiring intervention are feed/fodder production, value addition to milk and plan of action for business growth. Introduction of forage crops like sorghum, lucerne, oats, vetch, Napier grass, and others. Already, the study area is noted for growing groundnut, soya bean, maize, sorghum, etc. which can be further developed into crop-livestock farming. Among the much desired inputs are provision of financial, scientific and technical supports, to develop relevant infrastructure (borehole, earth dams, nomadic schools, etc.) are crucial to the realization of sustainable livestock and dairy development value chain.

3.16. Livestock and Dairy Production Potential for Improving Peoples' Livelihood

Ordinarily, milk is sold unprocessed in Africa [8] by hawking in villages, towns and markets in many parts of the country. This practice has to change by transferring modern technical knowledge on how to have value-added products such as cheese and yogurt that will be highly profitable to the farmers. Essential institutional role the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) should play in this regard cannot be underscored. In as much as the study area holds good promise for business growth in dairy value chain development: a prototype cluster of dairy cow smallholder farmers can be established in the six LGAs of ENSD. An innovative approach to collecting milk from pastoral herders and the proposed pilot cluster of smallholder dairy cow farms can as well be replicated in ENSD, other parts of Edo State and South-South Geopolitical Zone. Among the major constraints to smallholder farming in Nigeria include the lack and high cost of labor and agricultural inputs in rural areas; limited access to information, modern agricultural technology, and adequate financial services; a land tenure system that prevents the acquisition of new lands; and inconsistent support from the local governments [36] as cited by Anderson, et al. [37]. There is no doubt that this will involve the introduction of improved husbandry practices: by selection of dairy cows, better feed management and the control of tsetse fly, training in good hygienic practice in milk handling and processing are central to effecting the desired change. The study area holds great potential to support ruminant production to overcome the supply and demand deficits, which is presently addressed from informal trade or import from neighbouring countries like Chad, Niger and Mali [38].

3.17. Dairy Products Processing

All the dairy products on sale are from outside the ENSD and the state therefore, the consumption of milk will invariably be very low. Report from household survey in Nigeria by Anderson, et al. [37] showed that milk consumption was higher among producers: pastoralists (0.61), agropastoralist (0.49), commercial (2.0), and least among non-producers (0.11) litres per week per capita. Viable business opportunities at the small/medium/large scale enterprise in milk or dairy product processing is assumed could have high rate of return on investment between 1.2 - 1.3. Volume of milk produced determined the volume of milk offered for sale. A significant disparity ($p=0.0008$) in mean daily milk income reported by households in Kano State was higher than that of Oyo State was attributed to difference in the unit price for milk. Milk consumption was positively correlated with level of production both at the household [30]. This has demonstrated there are good prospects to upscale any or combination of the process line for producing skim milk, whole pasteurized milk, butter milk, powdered milk, cultured fermented milk or yogurt with or without fruit additives, whey the largest by-product of milk, casein, lactose, and cheese of different varieties [38]. In Nigeria, there is good business prospect to overcome the challenge in sourcing milk locally to fill the existing huge gap in supply and demand for milk or dairy products of about 1.4 million metric tons per annum. A call for optimal utilization of available vast arable land resources presently underutilized and refusal to embrace modern intensive crop and livestock farming methods cannot be ignored.

3.18. State of Cattle Market Dynamics

Milk consumption was positively correlated with level of production both at the household [30]. The marketing of milk and dairy products in the study area is yet to be fully developed because livestock production

value chain is not fully entrenched as few people are engaged as beef producers and marketing agents. Only few persons in each LGA have ventured into cattle fattening, Brokers/Middle men (*Barandas* or hagglers) during festive period, livestock retailers, dealers/wholesalers called (*Dillalai*) in Hausa and butchers are found mainly in major markets. The role of Barandas is to provide help or assistance to new buyers or sellers usually regarded as amateurs in the cattle business [39] is fast gaining ground in southwest of Nigeria. Only very few new cattle markets are evolving at Auchi, Okpila and Avhuele all in Etsako West LGA. Similarly, only at Auchi and Avhuele have thriving daily markets where cow is slaughtered, whereas others; Igarra, Fugar, Sabon Gidan Ora and Agenebode, Jattu, Okpila and Agbede have fixed market days.

3.19. Knowledge of the Disease, Transmission and Symptoms

The study showed that a good number of respondents, n=73 (85%) has a good knowledge of AAT and symptoms of the disease despite low level of formal education; they seem to be aware of the diseases that affected their livestock. Most herders recognized the highest prevalent diseases as liver flukes 40%, Samore 40%, foot and mouth disease (FMD) 10% and black water disease (cowdriosis) 10%. Almost all the herders correctly described clinical signs and symptoms of AAT to include poor hair coat or raised rough hair, geophagia, lacrimation that appeared more conspicuous and frequently seen than others (Figure 3), loss of weight, loss of appetite, etc. On the contrary, the result showed that majority of respondents 63 (74.1%) of pastoralists do not know the mode of transmission. This outcome could be attributed to lack of formal education. All the herders have good knowledge about the vectors. Some of the respondents claimed that it was indigenous technical knowledge acquired from parents and others said it is based on field experience gathered over the years. On gross clinical examination by physical inspection of animals in most herds (n=10) were in very good body condition (Figure 4). Most cattle belonged to zebu breed (*Bos indicus*) are generally described as trypano susceptible sparse with few Bororo. This might be due to availability of adequate pasture and water that abounds in the area hence, animals undergo less trekking during open grazing.



Figure 3. Cows showing lacrimal discharge (Arrows).



Figure 4. Animals are in physically good body condition.

Treatment seeking behaviour of herders is shown in Table 4 with majority of respondents 76 (89.4%) treated their livestock without consulting a veterinary doctor. They expressed believe that the explanation they gave drug vendors sometimes backfire and the treatment veterinarian gave can easily be repeated without further consulting any professional. Only 5 (5.8%) of the herders made use of the services of veterinary doctors; and the physical appearance of their herds appeared healthier than the others. However, a third group of respondents 4 (4.7%) consulted veterinary drug vendors. This group consists mainly of people who think veterinary drug vendors have the same professional competence with veterinary doctors, and as such, they believe they are getting the right treatment. Majority performed treatment of animals and administered the drug by themselves without any qualified veterinary medical supervision, a similar practice has been observed by Osue, et al. [40] in parts of Kaduna State.

Table 4. Treatment seeking behaviour and types of drugs commonly in use.

S/No.	Types of treatment sought	Respondents	Percentage
1.	Contacted veterinary doctor	5	5.8
2.	Contacted drug vendors	4	4.7
3.	Undertake self-treatment	76	89.4
4	Use of traditional medicine	0	0
5.	Long acting antibiotic	52	61%
6.	Samorin	18	21%
7.	Procaine	4	4.7%
8.	Diminazene aceturate	11	12.9%

3.20. Drugs Used for Self-Treatment

Pastoralists' knowledge about the choice of drug to be used for treating AAT appears minimal despite knowing the disease and been able to clinically diagnose it. Yet, majority could not say the right drug to use with 61% mentioned L.A (which is long active oxytetracycline hydrochloride (HCl), 50mg/ml). This oil-based antibiotic doesn't act on trypanosome parasites. Another drug used is Bulium Bulylo 20TM injection 20%. Each ml contains Tylosin Tartrate 200mg used for pneumonia, arthritis and enteritis. Only 21% of the respondents mentioned Samorin as their drug of choice when trypanosomosis (*Samore*) infection is suspected in the herd. This set of respondents appeared to be very knowledgeable about the disease and treatment because Samorin is a prophylactic drug against trypanosomosis was used for curative treatment. The next set of respondents chose a drug (Procaine) that is not in any way related to trypanosomosis; coincidentally they are very few (4.7%) who indulged in such treatment. The last group (12.9%) could not mention the exact drug name used but were able to describe and give the spellings on the drug pack identified to be Berenil®, a compound of Diminazene Aceturate has over the years been very effective in the treatment of animal trypanosomiasis in sub-Saharan Africa [41]. Therefore, only those respondents, 29 (33.9%) that use the two trypanocides (Samorin® and Berenil®) had made accurate choice of drug. Far reaching implication of self-administration of trypanocides is incorrect dosage and improper handling of trypanocides may lead to under-dosage with inherent possibility of drug-resistance developing.

3.21. Knowledge and Control of Tsetse and Other Biting Flies

A general claim of ubiquitous presence of tsetse and other biting flies were made by all key informants and herders. They said there is always increase in fly population during raining season, and as a result, they are forced to move their animals away from infested locations. Studies undertaken elsewhere in Kaduna, Nigeria, by Ahmed, et al. [42] showed the presence of dipteran biting flies that belonged to two families, Tabanidae and Muscidae, distributed in 4 genera: *Tabanus*, *Haematopota*, *Crysops*, and *Stomoxys* were reported. Majority of respondent herders affirmed the presence of these same haematophagous dipterans constitute biting menace. These flies will no doubt play significant roles in mechanical transmission of trypanosomosis and other diseases, which frequency and intensity may be heightened during the period with relative abundance and particularly more during the wet

season. They complained of one particular type of fly, when it is present causes the animals to be very restless and with blood oozing out from point of bite. From description given by herders clearly indicated that in addition to the presence of tsetse there are other biting flies and insects such as ticks, mites, and blow fly.

All herders affirmed control of biting flies by purchasing insecticides from local veterinary and chemical stores, which is applied dorsal laterally on animals. One of the two such insecticides widely in use is DDForce or DDVP: is an organophosphate compound containing Dichlorovinyl dimethyl phosphate or Dichlorvos with active ingredient for agricultural uses only and as stomach poison, with contact and respiratory action. The solution is used for treatment, control, prevention, and improvement of diseases, conditions and symptoms: as insecticide and anti-helminthiasis. It is acclaimed to be effective against aphid, termites, spider mites, caterpillars, thrips, and whiteflies in wide range of crops. Cypermethrin (CP) is a light stable synthetic pyrethroid broad spectrum insecticide that kills beneficial insects as well as target insects [43]. Cypermethrin is for veterinary use in cattle, sheep, goats, poultry, horses, dogs, and cats against external parasites: ticks, flies, fleas, lice and mite. Both insecticides were used as pour-on by all the herders [44]. Majority of herders are well abreast of the beneficial insecticide application in livestock production as a private good. Majority of users do not know the safety issues of insecticides.

3.22. Herders' Perceived Challenges Facing Livestock Production

The majority of herders identified in unequivocal terms, the legion of challenges hindering the appreciable improvement of livestock productivity as essentially the lack of access to grazing land title. This has wider ramifications and multiple influences on sustained nomadic lifestyle, inability to modernize and adapt to new husbandry management systems such as sedentary lifestyle. Most of pastoralists lamented absence of grazing reserves in the area thereby leading to dependence on the forest reserves to avoid conflicts with the crop farmers, which often occur due to lack of cattle route. Influx of herders from northern parts of Nigeria is linked to negative impact of climate change and the collapse of 415 grazing reserves (GRs). Encroachment and contention with farmers for both the demarcated and gazette (114) and non-gazette (301), and many cattle routes across the country are responsible for the frequent herders-farmers' clashes. The second most important challenge was blamed on lack of strong support from governments at the three tiers of governance and from NGOs. Attempt by Federal Government to re-establish GR in states was met with vehement opposition mounted by farming communities across the country [45]. In reality, the idea of grazing reserves development (GRD) is no longer attractive and fashionable nor appealing especially to crop farmers who are denied access to the rich arable land is a factor Farmers vehemently resented it because of increasing crop farming activities coupled with other growing competing infrastructural development needs. There is no better time than now for paradigm shift from extensive to intensive crop and livestock farming systems. This may likely be the antidote to minimize and possibly eliminate conflicts between herders and crop farmers, which have been entrenched as reoccurring social vices bedeviling many countries of West Africa sub-region and beyond. To keep pace with increasing population and resultant pressure on the limited available arable land with good pasture within the sub-humid and humid ecological zones of Nigeria demands expedient change in livestock management system as shown on [Figure 5](#).

It behooves government now more than ever, to embark on the expedient implementation of various policies that were enunciated in the NLDP of the Federal Government of Nigeria, [1] FAO that emphasized the importance to transform from extensive to semi-intensive then to intensive animal management system. Summary of the various components of these systems are highlighted in [Federal Ministry of Agriculture and Rural Development FMARD \[5\]](#). The study area can play relevant and crucial roles in producing livestock and dairy products in Nigeria and the sub-region to enhance GDP through the optimal utilization of its huge natural resources, which can be approached from abstraction of tangible and non-tangible goods and services. It is not a misplaced priority to start the disbursement of ranch intervention fund in seven among the initial ten focus states of Adamawa, Benue, Ebonyi, Edo, Kaduna, Nasarawa, Oyo, Plateau, Taraba, and Zamfara under the National

Livestock Transformation Plan of 2019-2027. It is expected that by 2027, the NLTP approved on January 17, 2019 to be coordinated by the National Economic Council (NEC would have developed market-driven ranches in the seven target states, establish 63 pasture lands and 1 semen bank in each target state and must as well artificially inseminate at least 170,000 cows [46]. This is a very ambitious strategic plan with semblance to that of the NLDP of 1974 as cited by [Nigeria livestock Development Project \(English\) \[47\]](#) funded by the World Bank.

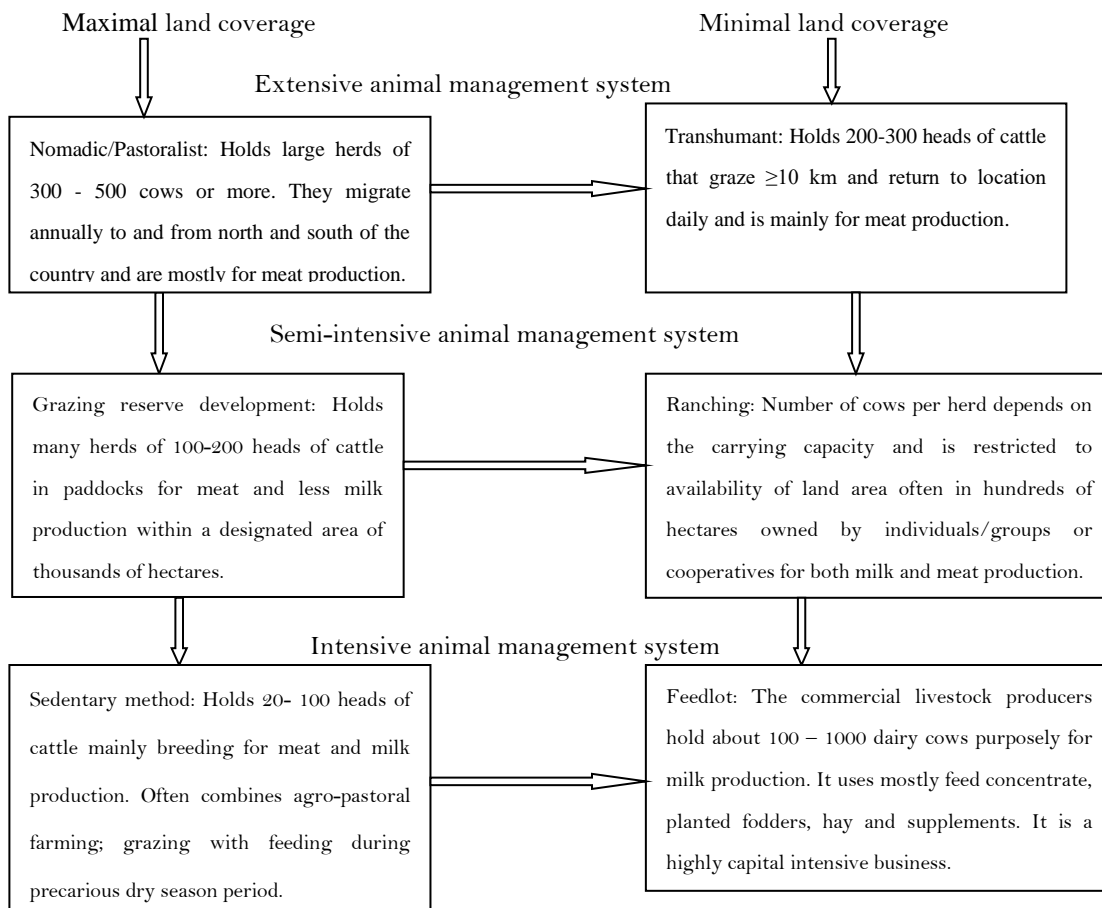


Figure 5. The schematic flow chart represents the process of transiting from extensive to intensive animal management system.

Thirdly, they decried non-existence of Research Extension workers as obtained with different types of plants or crop commodities like maize, cassava, yam, rice, soya bean, cocoa, ginger, sorghum, wheat, palm, etc. It could be inferred that predominance of one tribe controlling over 90% of livestock population may be responsible for the unwillingness of NGDOs to show interest. The Fulani pan-cultural body, MACBAN, Pastoral Resolve, Miyetti Allah Kautal Hore (MAKH) and other affiliated groups should be able to interface between herders and development partners; government and NGDO to step up intervention support to livestock development in Nigeria.

3.23. Tsetse and Trypanosomosis Control Options

Control directed at the tsetse fly can be tailored for focal and area-wide deployment of environmental friendly tools such as insecticide impregnated screens and targets, and traps are used for entomological assessment. This strategy should incorporate the active participation of herders who are already use-to applying insecticide on cattle. Restricted application of commercially available insecticide chemical compound formulations by the herders can be encouraged and educated on how it can be applied appropriately to achieve the desired result. Skills for tsetse trapping techniques should be transferred to grassroots stakeholders as a component of research extension without any doubt remain very vital for sustainable TAT control. Judicious use of trypanocidal drugs should be advocated and canvassed and evaluation of the efficacy of the drugs from different manufacturers deserved to be routinely

undertaken. In a study by Meyer, et al. [48] showed the costs of implementing the control interventions were divided between administrative overheads, field costs and monitoring costs. The latter costs included initial entomological and parasitological surveys as well as subsequent T&T monitoring activities, all of which varied in relation to the level of the control activity. The authors produced BCRs for AAT control interventions in Cameroon and Zambia ranging between 2.0 and 4.6, indicating local tsetse elimination would be cost-beneficial in both settings. In other studies in Senegal reported 0.98 and 4.26 BCR. In a study carried out in Burkina Faso by Brandl [49] had shown that the monetary output from cattle production might increase by 12% to 74%, according to the different scenarios and the intensity of the production losses attributable to the AAT challenge.

3.24. Implication of Tsetse Control and Increased Animal Population

Agriculture and animal husbandry are important contributors to global emissions of greenhouse gases (GHG) and acidifying gases. Moreover, they contribute to water pollution and to consumption of non-renewable natural resources such as land and energy [50]. Any appreciable improvement on cattle population will invariably lead to increased carbon dioxide emission. Carbon dioxide produced by cattle varied according to time of the day and animal's weight; cattle weighing 500 kg produced carbon dioxide at a mean rate of 2.0 litre min⁻¹ in the morning and 2.8 litres min⁻¹ in the afternoon compared to respective rates of 1.0 litre min⁻¹ and 1.9 litres min⁻¹ for cattle weighing 250 kg [51]. Similarly, any increase in livestock population will consequentially have direct commensurate influence on the amount of cow dung. Accumulation of dung, if not properly managed could lead to emission of offensive odour and release of GHG, mainly ammonia (NH₄), carbondioxide (CO₂), methane (CH₃), and nitrous oxide (N₂O). Therefore, intensification and increased efficiency of livestock production means fewer greenhouse gases per unit of milk and more milk per water unit [52]. Invariably the preponderance increase in GHG production from livestock and livestock waste contribute to global warming or climate change. The farming strategy based on high conversion efficiency at animal level was identified as the most effective to mitigate the environmental impact per kg milk at farm gate, especially in terms of GHG production and non-renewable energy use per kg Fat and Protein Corrected Milk (FPCM) [50].

3.25. Sustainability of Tsetse and African Animal Trypanosomosis Control

Among the global efforts to tackle nutritional deficiencies in school aged children, 30 European countries had adapted milk distribution strategy. Comparatively, the Nigeria school feeding programme could rely on dairy products which are amenable to food fortification with vitamins A, D and E and essential trace minerals such as magnesium, zinc, calcium, etc. [53]. Thence, Edo north in particular and the entire Edo State and South-South geopolitical zone technically fall under the top priority for control and eradication of the vector and the disease. Invariably, from our assessment, the area practically has very high cost benefit ratio (CBR) with high rate of return on investment (ROI) in livestock and dairy production based on its huge natural endowments already enumerated. Despite no case of human sleeping sickness has been reported in the state for so many years does not rule out its presence goes with the common saying that "not catching a fish does not mean there is no fish in the river". Going by the example with ROI between 33 and 43 percent estimated after tsetse eradication in southern Ethiopia [54] re-enforced the fact that the addition of cost of tsetse and animal trypanosomosis into livestock production cost will not substantially affect ROI as observed by Osue, et al. [55] in a study Kano State. In a study by Mafimisebi, et al. [56] had reported profitability ratio and operational efficiency of 1.09, 1.07 and 1.03 for cattle dealers, retailers and brokers, respectively. Tsetse control benefit analyses from many previous studies had tripled milk production, doubled beef production, and a five-fold rise in the number of farmers who fertilized crops with manure were reported after tsetse elimination in Zanzibar, Tanzania [57]. Apart from human population density and cost-benefit analysis during fly management as illustrated, in a study by Shaw, et al. [58] show that the benefits of different control options are heavily influenced by cattle densities.

Secondly, insecticide treated cattle (i.e. pour-on, manual spraying, community dip bath) and insecticide treated target (traps and screens impregnated with insecticides) are available and should be complemented with diagnostic tests and medication (trypanocides with prophylactic and/or therapeutic action). Thirdly, active engagement of communities, farmers and herders in the study area is very necessary so as to enlist their active participation and key into the project. On a scale of preference between the application of two intervention methods, it was found that insecticide treated cattle was the most suitable and acceptable by farmers, because they protect a private good i.e. cattle, whereas insecticide treated targets are generally considered to provide a public good [40, 59]. Thirdly, the active involvement and engagement of communities, farmers and herders, enlisting their active participation is essential from the conception stage of any innovative control strategies before commencing implementation cannot be overemphasized.

3.26. *Indigenes Respondents' Knowledge of Human African Trypanosomiasis (HAT)*

This study showed that most of the respondents 300 (85.71%) knew about the disease HAT or sleeping sickness, however a minority of the respondents 50 (14.28.0%) still do not know the disease. 250 (71.42%) respondents considered excessive sleep as a disease and have some knowledge about sleeping sickness and majority 300 (85.71%) with 120 (80%) and 180 (90%) from Owan East and Owan West, respectively identified tsetse fly as the vector that transmit the disease. They pointed to farms/bushes as the major habitat where tsetse flies can be found. Peridomestic behaviour of flies with presence reported in dwellings houses was mentioned by 120 (80%). Respondents were not familiar with the symptoms of sleeping sickness and treatment options available.

3.27. *Respondents' Attitude and Practice towards Prevention and Control of Human African Trypanosomiasis*

Most respondents' attitude towards the disease is quite poor, even though 300 respondents (85.71%) felt the disease could lead to death. Most respondents do not have an in-depth knowledge of HAT but can identify the tsetse fly, 320 (91.42%) with 130 (86.7%) and 190 (95%) for the LGAs, respectively. Many were of the view that people can prevent bite from tsetse flies by covering the body when working in the farm. They also showed a local crafted material made from raffia used in killing tsetse fly, called *Agbuza* in Owan dialect as shown on Figure 6. None of them can recognize a person suffering from sleeping sickness nor has directly or indirectly seen a treated case of the disease. On the contrary, most respondents (herders) have good knowledge of the disease, animal African trypanosomiasis as *Sammore*, and the relevant clinical signs and symptoms used in presumptive diagnosis. Yet, the majority was not aware of the causative agent, mechanism of transmission and how to prevent the disease. They were conversant with the methods of controlling biting flies including tsetse fly with the use of insecticides applied on animal bodies, which is practised virtually by all the herders. Since insecticides are widely used, it could be exploited as private goods rather than public goods for the purpose of sharing the cost of TAT control. Figure 7 illustrates two samples of insecticides in use were purchased from open market and the efficacy of the products remained unknown. All the herders said they followed the instructions as provided on each product label.



Figure 6. Traditional tsetse fly killer called *Agbuza* in Owan dialect.



Figure 7. Sample insecticides widely used in the area.

4. CONCLUSION AND RECOMMENDATIONS

Our study clearly showed that this area is yet to make any meaningful utilization of the huge natural resources available for socioeconomic growth and sustainable agricultural and rural development (SARD). It re-enforce implicitly or explicitly, how the lack of knowledge sharing has hindered ability and capacity to increase its contribution to GDP, neither improving the livelihood nor the living standard of the people. Absence of an all-inclusive participatory and strategic approach involving the relevant stakeholders' ownership of livestock and dairy value chains as important agribusiness remained abysmally under-exploited. Furthermore, both direct and many indirect benefits from mixed crop-livestock farming, synergy between crop and livestock including exchange of by-products from crop and livestock (fodder and manure), slurry from bio-digester for domestic cooking gas and sludge application as organic fertilizer, and the use of animals for traction to pull cart and to plough farmland are non-existence in the area.

Apart from the tsetse fly menace and animal trypanosomosis challenges posing serious limitations to mixed crop-livestock farming, the incessant land disputes particularly the herders-farmers and communal conflicts have made situation more perplexing. Following the extrapolated qualitative and quantitative extraction and objectively verifiable data and information canvassed thus far support the obvious socio-economic consequences of not utilizing the environmental and ecological endowed huge natural resources in the study area. Strategic planning and concerted efforts are needed to effectively and efficiently develop livestock and dairy value chain to enhance job and wealth creation. Applying the "Theory of Change (ToC)" concept could provide the much needed insight on how design and structured partnership arrangements can be used to foster optimization of socio-economic benefits.

A solid analysis of a theory of change can be extremely useful, both for designing or assessing the designs of an intervention as well as for the design of monitoring regimes and evaluations [60]. All herders decried inability to increase local meat and milk production by cross-breeding of dairy cattle population. A systematic policy through coordinated public private partnership, multidisciplinary, multi-sectorial and multilateral cooperation and collaborative intervention to modernize animal husbandry practices from pastoralism to ranching through better feed management, tsetse fly control, and training in good hygienic milk handling and processing are critical imperatives.

There is no doubt that the benefits to be derived by Edo State as one of the 10 frontline states in the National Livestock Transformation Project will outweigh the perceived negative consequences. With concerted efforts of stakeholders and the people towards the provision of adequate security which is the primary responsibility of government and the duty incumbent on all and sundry is a *sine qua non* for the outlined laudable objectives to be attained.

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