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Household Baseline Survey on Indigenous Chicken Production Characteristics and Constraints in Busia and Machakos Counties of Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. Authors CIM and OBB designed the expt, wrote the protocols, did the study and wrote the first draft of the manuscript. Authors IO and EOM supervised the study. Authors CIM and OBB participated in baseline data collection. Authors PA and CIM corrected the manuscript and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To collect preliminary baseline data prior to validation of three climate-smart technologies.
Study Design: A structured questionnaire was employed with participation of actors along the Indigenous Chicken value chain.
Place and Duration of Study: Study was conducted from May 2019 to June 2020 within four (4) Sub-Counties in Busia and Machakos where high Indigenous Chicken populations are found.
Methodology: A total of 160 households were surveyed. Targeted household information was recorded viz: distribution of respondents by village in the Counties; farmer socio-economic factors; flock structure and characteristics; disease and parasite constraints, management practices; disease reporting and communication amongst recruited farmers.
Results: Results revealed that 56.5% of the respondents were male and 43.5% were female wit mean age of 50 years. Most farmers had formal education (97%) and practiced semi extensive

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poultry farming system (59%). Both indigenous and exotic chicken (62%) were kept for income purposes (82.6%) and only young chicks received feed supplements (55.8%). Newcastle (18.5%) and coccidiosis (16.4%) comprised the two major disease constraints reported. Prevalent bird disease symptoms were diarrhea (24.9%) and coughing (23.1%) while mites (27.9%) and fleas (22.3%) dominated the ecto-parasites. Disease control strategies comprised: vaccines (72.8%), dewormers (44.9%) and ethno-veterinary medicine. *Aloe secundiflora* and *Aloe feroxin*, were singled out as locally available and effective means of treating diarrhea (62.9%), respiratory infections (61.9%) and worm control (64.5%). Most Indigenous Chicken farmers (76.8%) failed to report illnesses among their flock and did not access to health services (72.1%). Farmers accessed health information through radio (26.5%) as opposed to mobile phones (1.65%).

Conclusion: Findings of this survey reveal a low-grade free-range poultry system characterized by poor disease control. This scenario calls for targeted efforts by both government and private stakeholders to improve Indigenous Chicken management and help farmers adopt alternative climatic smart disease control interventions.

Keywords: Baseline survey; indigenous chicken; production characteristics; constraints; Busia; Machakos.

1. INTRODUCTION

In Kenya, the poultry population is estimated at 43 million, 80% of which are indigenous Chicken (IC) [1]. IC population is concentrated in the rural areas among poor smallholder farmers who are worst hit by climate shocks.The IC sub-sector produces 61% of poultry meat and 47% of the eggs and employment for over 3 million people in the country [1]. To the Kenyan economy, IC contributes 6% of the livestock GDP and 0.7% of the total GDP [1]. IC production is especially attractive to women and youth in Kenya as it requires low start-up capital and low maintenance cost [2, 3]. Moreover, it is common among smallholder mixed crop-livestock farmers who rely on their chicken in the event of drought and crop failure [2, 3]. To these rural poor farmers, IC provides affordable animal protein, cash incomes, manure and socio-cultural value [4].

Outbreaks of diseases such as Newcastle Disease (ND), Gumboro, helminths and coccidial parasites in IC increase with changing climate. Diseases cause huge economic losses through reduced productivity, high mortality and high costs of treatment. This leads to indiscriminate use of antimicrobials resulting in antimicrobial residues in IC products and antimicrobial resistance (AMR) in human and animals [5]. This is a food safety concern.

In order to uphold the high demand for IC products and increase profits along the IC value chain, there is need for effective disease control options which minimize antimicrobial residues. Little success has been attained in Kenya in containing these diseases and the population continues to incur losses of about US$ 100 million per annum [6]Vaccination failures have been reported following the use of IBD and ND vaccines in IC, this discourages the use of these vaccines among farmers. The use of efficacious and effective vaccines is key in controlling these diseases. For ND, the thermostable I-2 vaccine is promising for use in IC in Kenya as it does not require a cold chain and is thus suitable for use in remote areas where IC are kept [7]. However, the vaccine thermo-stability is not assured in very adverse conditions under which it needs to be first tested [8]. The D78 IBD vaccine has shown good protection against IBD under laboratory conditions (Bwana et al., 2017). However, with frequent reports of vaccination failures using current IBD vaccines [9], there is need to validate the current IBD vaccines under field conditions. Herbal plants are safe cost-effective alternative medicines [10]. The tremendous potential of herbal medicinal plants could be made practical with the use of formulations with extracted active ingredients. This would be useful to farmers. *Aloe secundiflora* extracts is one such formulation that has shown promising efficacy against parasitic infection under laboratory conditions [1]. For future prospects and promotion of alternative medicines, it would be more informative and useful to validate this extract with farmers under field conditions.

Diseasesurveillance system in Kenya is limited by poor [11]. This often results in difficulty enforcing control. The Directorate of Veterinary services has introduced Kenya Animal Bio-surveillance System (KABS), an ICT-tool to monitor animal diseases [11]. The tool has potential to improve disease and AMR monitoring in IC. The proposed project will contribute to disease control in IC, enhanced productivity and build resilience of rural communities to climate shock. It will also contribute to the Big Four Agenda's pillar on nutritional security and universal health. Since IC is one of the most abundant assets among women, youth and HIV-affected households, the proposed project will ensure their involvement and the project output and outcome will impact on the livelihoods and socioeconomic status of these vulnerable group.

There is a projected double increase in demand for IC and their products by 2030 [12]. This presents an opportunity for the transformation of the IC into a vibrant, commercial and profitable sub-sector with the potential to create more jobs and income along the value chain. However, rampant diseases mainly, Newcastle disease, Infectious Bursal Disease (IBD) and parasitic infections have hampered the transformation of IC into a profitable sub-sector [13,14]. Currently, there IC sub-sector is experiencing increased disease outbreaks due to modification of disease pathogens and a decrease of IC immunity resulting from variable and extreme weather events [15].The inability of the IC owners to control these diseases makes their impact even greater in this sub-sector. They therefore result in high mortality and economic losses along the IC value chain.

Herbal plants are safe cost-effective alternative medicines [10]. The tremendous potential of herbal medicinal plants could be made practical with the use of formulations with extracted active ingredients. This would be useful to farmers. *Aloe secundiflora* extracts is one such formulation that has shown promising efficacy against parasitic infection under laboratory conditions [1]. For future prospects and promotion of alternative medicines, it would be more informative and useful to validate this extract with farmers under field conditions. Disease surveillance system in Kenya is limited by poor reporting[11]whichoften results in difficulty in enforcing control.

The broad objective of this World Bank-funded project was to validate three climate-smart technologies namely: thermostable I-2 and D78® IBD vaccines to enhance control of Newcastle and Gumboro diseases; the ICT-based system for disease surveillance and antimicrobial resistance; and potent *Aloe secundiflora* leaf extracts formulation for controlling ascariasis and coccidiosis in indigenous chickens (IC).The specific objective of this study was to collect preliminary baseline data using a structured questionnaire prior to validation of the three climate-smart technologies in the project sites.Critical IC parameters were collected namely distribution of respondents by village in the Counties**;** farmer socio-economic factors; flock structure and characteristics; disease and parasite constraints, management practices; disease reporting and communication among recruited farmers. This project responds to climate change-induced infectious and parasitic diseases that increase mortality and seriously reduce IC productivity in Kenya.

2. METHODOLOGY

2.1 Study Site

The study was carried out within two counties of Busia and Machakos, Kenya. The counties were purposively selected from amongst the KCSAP project locations to represent the high rainfall, semi-arid and arid zones, with high IC population and their importance to the livelihoods.Busia County is situated in western Kenya and covers an area of 1,694.5 square kilometres (km^2). It lies between latitude 0º and 0º 45 North and longitude 34º 25 East. The altitude is undulating and rises from about 1,130 meters (m) above sea level at the shores of Lake Victoria to a maximum of about 1,500m in the Samia and North Teso Hills. Busia County receives an annual rainfall of between 7millimeters (mm) and 2000 mm.Agriculture, fishing and trade are the main economic activities especially in the lower Northern parts including Nambale, Butula and Teso South are suitable for maize, livestock, poultry, robusta coffee and sugar cane cultivation (Government of Kenya, 2018; Busia County Integrated Development Plan of 2018).

Machakos County lies between latitudes 0º 45´ South and 1º 31´ South and longitudes 36º 45´ East and 37º 45´ East, and covers a total area of 6208.2 km². The County receives bimodal rainfall ranging between 500mm and 1250mm and is unevenly distributed and unreliable. Temperatures vary between 18˚C and 29˚C throughout the year. Agriculture is the main economic activity in the County, which is largely semi-arid. Most of the crops grown include maize, beans, fruits, vegetables and drought-resistant crops such as sorghum and millet.

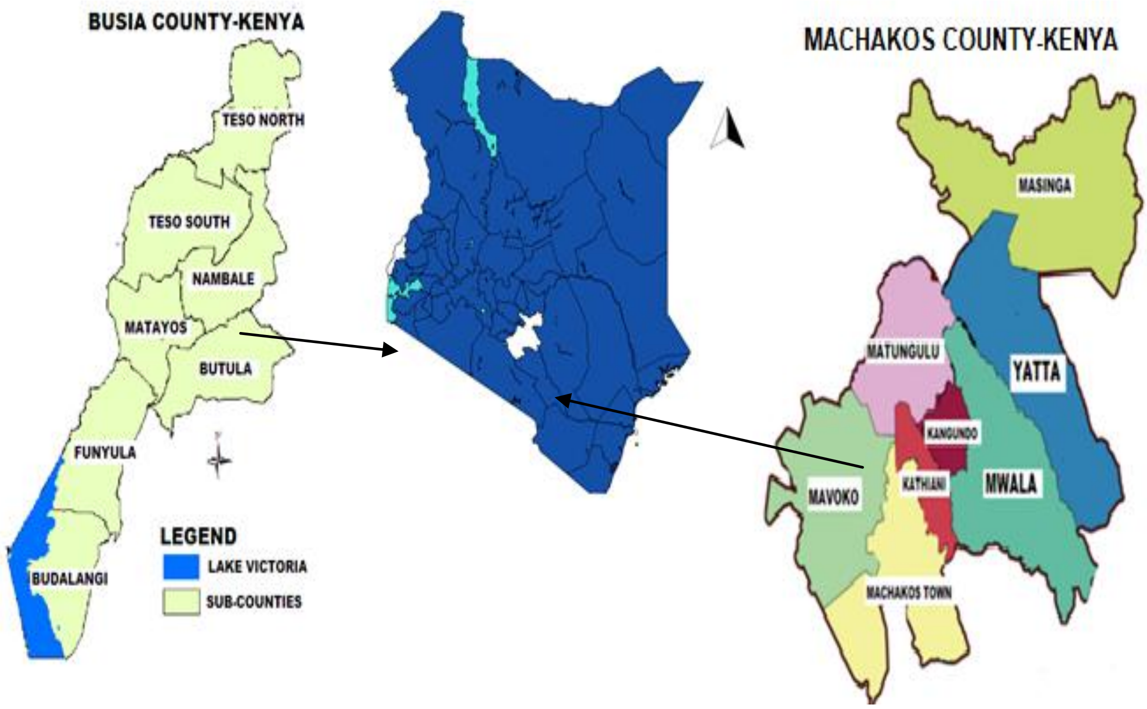

Fig. 1. Map of Kenya, Inset location of Busia and Machakos counties

2.2 Sampling Frame and Sample Size Determination

The study involved key IC value chain actors: input suppliers, veterinary service providers, IC producers, IC bulkers, traders and transporters. The source population comprised of IC producers/farmers, 40 input suppliers, 20 veterinary providers, 60 IC tradersof Busia and Machakos. Out of these, only 160 households were interviewed. Specific household information was recorded.

The required total number of respondents was determined using the formula by Cochran [16] for infinite population.

$$n = \frac{Z^2pq}{e^2}$$

= [(1.96)2 × (0.11) (0.89)]/ (0.05)2
= [3.8416 × 0.0968]/ (0.0025)
= 160 households

Where:

n = required sample size.
Z^2 = the abscissa of the normal curve that cuts offan area at the tails (1-α) (95% = 1.96).
e = the margin of error (e.g., ± 0.05% margin of error for confidence level of 95%).
p = the degree of variability in the attributes being measured, referring to the q = 1-p. (p)(q) are the estimates of variance. Where: q = 1−0.11 = 0.89.

Briefly, IC producers were selected using a multistage sampling approach. First, a list of sub-counties in the selected counties was prepared and sub-counties with the highest IC populations were purposively selected. In each selected sub-county, a list of wards was out of which two wards were purposively selected. The selection was based on IC population and accessibility. In each ward, four villages were purposively selected based on IC population and accessibility. In each village, a list of farmers was drawn with the assistance of county local lead farmers, livestock and veterinary officers.IC producers'/ producer groups with flock sizes of at least 10 birds were purposively pre-selected and a sampling frame prepared from where a simple random sample of 5 farmers per village were sampled working up to 120 farmers per county. The entry point to the communities was through the County Governments with whom the project was discussed and their assistance and support sought. The 120 farmers per county and other IC stakeholders at each project site were sensitized by the project team appropriately.

Table 1. Study sites (County, Sub-County Ward Village and their GPS coordinates

County	Sub-county	Ward	Village
Machakos	**Yatta**	Kithimani	KwaKitema (GPS: Lat -1.19632, long-37.4653)
			Nguumo (GPS: Lat -1.16529, long-37.420537)
			Muthesya (GPS: Lat -1.15945, long-37.500251)
			Utithini (GPS: Lat -1.1991109, long-37.444627
		Ndalani	Kwaleli (GPS: Lat -1.0724, long-37.4854)
			Kyeni (GPS: Lat -1.0800, long-37.4349)
			Mavoloni (GPS: Lat -1.10786, long-37.4169)
			Kamulu (GPS: Lat -1.1021, long-37.4523)
	Mwala	Mwala	Yanthooko(GPS: Lat -1.4200, long-37.4300)
			Mutuyu (GPS: Lat -1.2000, long-37.4000)
			KwaNdoo (GPS: Lat -1.3802, long-37.45732)
			Uini (GPS: Lat -1.3802, long-37.45732
		Masii	Kimwala (GPS: Lat -1.300, long-37.4823)
			Kanduu (GPS: Lat -1.3291, long-37.5247)
			Matulani(GPS: Lat -1.3567, long-37.4765)
			Kitulia (GPS: Lat -1.3740, long-37.5271)
Busia	**Teso-South**	Amukura West	Amairo (GPS: Lat 0.6231, long-34.19762)
			Machakusi (GPS: Lat 0.6005, long-34.2561)
			Osuret (GPS: Lat 0.6361, long-34.2147)
			Parater (GPS: Lat 0.6205, long-34.18231)
		Amukura Central	Apatit (GPS: Lat 0.5822, long-34.2301)
			Achunet (GPS: Lat 0.5829, long-34.2456)
			SimbaChai (GPS: Lat 0.5503, long-34.2517)
		Chakol North	Asing'e (GPS: Lat -0.5723, long-34.1824)
	Nambale	Bukhayo Central	Sikinga (GPS: Lat 0.4729, long-34.3811)
			Siekunya (GPS: Lat 0.47081, long-34.2527)
			Malanga (GPS: Lat 0.4291, long-34.3241)
			Lwanyange (GPS 0.4309, long-34.2886)
			Sidende (GPS: Lat 0.4745, long-34.2750)
		Bukhayo North	Musokoto(GPS: Lat 0.50163 long-34.2995)
			Khwirale (GPS: Lat 0.4821, long-34.2521)
			Otir (GPS: Lat 0.4897, long-34.2876)

2.3 Research Design

The survey was conducted between May 2019 and June 2020. An action research methodology was employed with participation, reflection and empowerment of actors along the IC value chain. Qualitative and quantitative methodologies were utilized to collect data for the baseline evaluation. Qualitative methods collected data on the opinion of stakeholders on the process and their attitude on the climate smart technologies. Gender dynamics were taken into account in order to get the representative opinion from men, women and youth. Key informant interviews were held with at least 2 key stakeholders per county. Quantitative methods were employed to gather IC production and productivity parameters such as disease incidence, flock sizes, chick survival, off-take and mortality rates. This data was collected before application and validation of the TIMPs technologies.

2.4 Data Management and Analysis

The process of data management involved cleaning the questionnaires for errors and coding quantitative data and then entry was made in the Epi-Info-7.2 software. The coded information was then managed and analyzed using Epi-Info and SPSS software. Descriptive statistics methods viz: means, frequencies and proportions were used to analyse data yielding results with different focuses.

2.5 Study Limitation

The COVID-19 spread and stringent government containment measures hindered timely implementation of project activities which stretched data collection period to one year running from May 2019 to June 2020. Infrastructural limitations in the project included poor road networks and difficult terrain. Active disease outbreaks at project sites such as fowl pox and New Castle affected household surveys.

3. RESULTS

3.1 Distribution of Respondents by Village within Busia and Machakos Counties

Results indicated that 51% of the respondents were from Busia whereas 49% were from Machakos. In Machakos County, (30%) where from Mwala and (21%) where from Yatta Sub-Counties while Nambale (20%) and Teso-South (29%) where from Busia County. In Busia County, the respondents' distribution by village was as follows: Achunet (7%), Amairo (3%), Asing'e (6%), Apatit (7%), Khwirare (3%), Isidende (3%), Musokoto (8%), Otir (5%) and Simba-chai (5%). In Machakos County the respondents were distributed as follows: Kalyambeu (5%), Kamulu (5%), Kanduu (3%), Kitulia (5%), Kiwanza (8%), Kwaleli (5%), Kyeni (5%), Kyumu(4%), Malumani (5%) and Manzoni (5%), see Fig. 2.

3.2 Farmer Socio-Economic Characteristics

Results showed that out of 147 farmers interviewed, 55% were male while 45% were female (Table 2). The average age of respondents was 50 years with a minimum of 27 years and a maximum of 95 years. Farmers had been keeping poultry for an average of 13 years ranging from 1 to 50 years (Table 2). Majority (97%) of respondents had formal education whilst 3% had no formal schooling. Agriculture (80%) was the main source of income as opposed to salary. Poultry keeping (52%) was the dominant farming system followed by mixed livestock (26%) and mixed crop and livestock (22%) respectively. Extensive (38%) and semi-extensive (59%) poultry farming systems were prevalent over intensive (3%) farming. As summarized in Table 1, majority (70%) of the respondents had registered as (CIG) while 30% had not. Moreover, majority (96%) were not registered members of VMGs (Table 2).

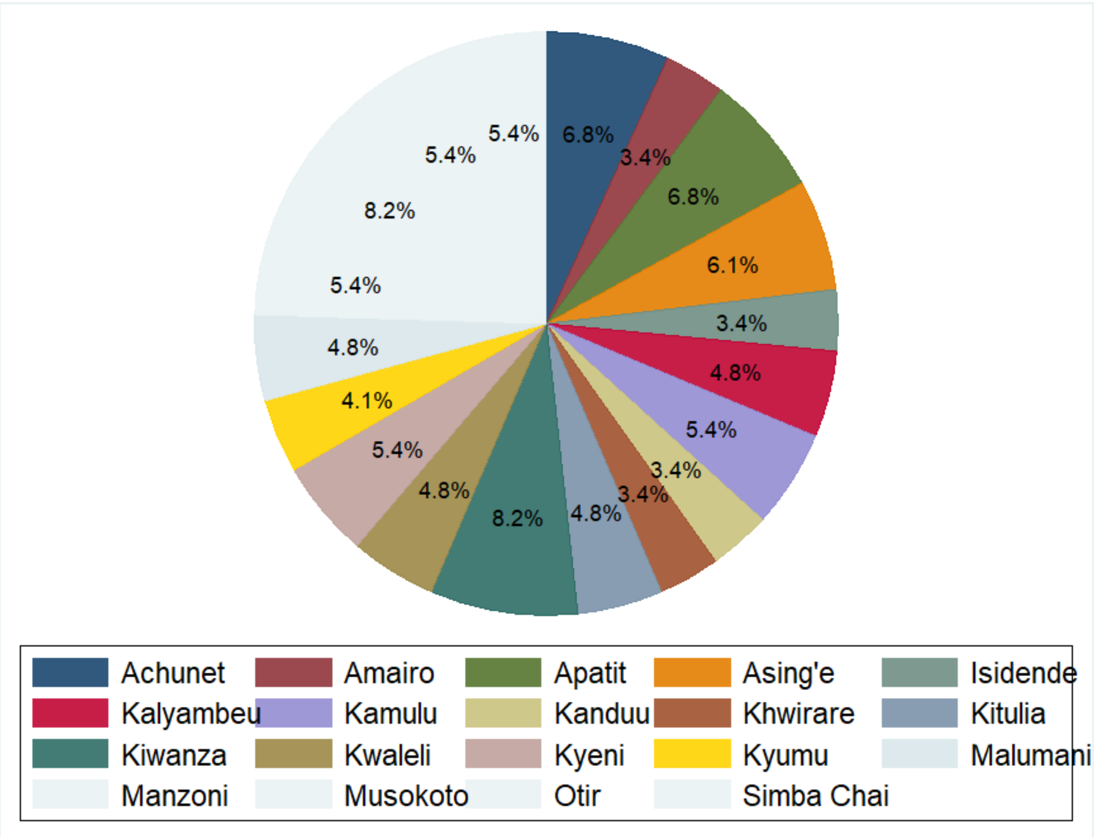

Fig. 2. Distribution of respondents by village Busia and Machakos Counties

Table 2. The Mean for farmer socio-economics characteristics

Variables	**Description**	**Busia Teso-South (n=42)**	**County Nambale (n=30)**	**Machakos Yatta (n=31)**	**County Mwala (n=44)**	**Overall mean**(%)
Household age	Age of the household	45.57 ±10.10	45.13±10.09	52.45±15.58	54.11±12.98	49.49±12.84
Years of keeping poultry	Years of poultry farming	10.19±6.29	9.33±3.45	13.35±10.39	17.68±14.03	12.93±10.39
Gender	Male	14.46	15.66	20.48	49.40	56.46
	Female	46.88	26.56	21.88	4.69	43.54
Household education	No formal education	0.00	0.00	0.00	2.04	2.04
	Primary level	32.76	15.52	27.59	24.14	39.46
	Secondary level	26.15	27.69	16.92	29.23	44.22
	Tertiary level	28.57	14.29	4.76	52.38	14.29
Income source	Agriculture	35.90	25.64	10.26	28.21	79.59
	Salaried employment	0.00	0.00	44.44	55.56	6.12
	Business	0.00	0.00	60.00	40.00	10.20
	Casual labour	0.00	0.00	4.08	0.00	4.08
Farming system	Mixed crop & Livestock	6.25	0.00	93.75	0.00	21.77
	Mixed Livestock	0.00	0.00	2.63	97.37	25.85
	Poultry Only	51.95	38.96	0.00	9.09	52.38
Poultry farming system	Extensive	0.00	0.00	38.60	61.40	38.78
	Semi-intensive	48.84	34.88	8.14	8.14	58.50
	Intensive	0.00	0.00	50.00	50.00	2.72
Registered as CIG	Yes	11.36	11.36	0.00	77.27	29.93
	No	35.92	24.27	30.10	9.71	70.07
Registered as VMG	Yes	83.33	0.00	16.67	0.00	4.08
	No	26.24	21.28	21.28	31.21	95.92

3.3 Characteristics of Indigenous Chicken (IC) Production System

The IC flock size, structure, dynamics and performance in the four Sub-Counties are presented in Table 3. Generally, the trend on the flock composition, dynamics and management practices followed the same pattern in all the counties. Majority (52%) of the farmers were rearing poultry mainly both indigenous and exotic breeds (62%) while (38%) kept indigenous chicken breeds only. The mean flock size was 43.14 chickens per household. The flock structure was mainly dominated by chicks (12.47 %), growers (10.67%) and hens (8.67%), whilst cocks were the least (3.83%) (Table 3). IC kept were primarily sold (18.56 %) to generate income as opposed to being consumed (13.50%) or given as gifts (3.20%). Most of the eggs laid (77.56%) were incubated with a mean hatchability of 52.99%, and chick survival rate of (38.23%) and (24.80%) for three and six months respectively (Table 3). Chicks and growers were mainly supplemented by concentrates (55.78%) and (36.73%) respectively feeds such as chick mash, growers mash whilst (35.37%) and (34.01%) correspondingly were scavenging without any supplements. Majority of growers and adult IC were mainly scavenging and received little or no feed supplements (37.43%), see Table 3.

3.4 Indigenous Chicken Disease and Parasite Constraints

Indigenous chicken (IC) disease and parasitic constraints are outlined in Table 4. Newcastle (18.48%) and Gumboro (17.54%) diseases were among the most prevalent diseases among IC followed by coccidiosis (16.35%), fowl pox (15.17%), Influenza Coryza (15.17%), whilst fowl cholera (2.61%) was the least prevalent. The most common infection symptoms were greenish diarrhoea (24.89%), coughing (23.11%), pox lesions (14.89%), white diarrhoea (14.67%), and bloody diarrhoea (12.89%) while difficulty breathing (4.00%) was the least (Table 4). The average mortality rates in the past one year among IC due to Newcastle, Gumboro, coccidiosis infections were (4.86%), (3.37%) and (1.57%) respectively (Table 3) while infection averages for Gumboro and coccidiosis were (4.34%) and (2.89%). In the last one year 45.58% of poultry farmers reported that they had experienced Newcastle outbreak, while 53.74% and 60.54% confirmed Gumboro and coccidiosis occurrences (Table 4). Mites (28.98%) were exemplified as the most prevalent parasites followed by fleas (27.92%), lice (22.26%), worms (20.49%) and others (0.35%) such as ticks (Table 4).

3.5 Indigenous Chicken Disease Control and Management

Disease control and management strategies among IC farmers are summarized in Table 5. Majority of farmers used dewormers (44.94%) compared to herbs (20.25%) while (34.81%) did not use any worm controlling strategy. Majority (72.79%) utilized vaccines in disease prevention mainly against Newcastle (51.76%) and Gumboro (34.67%) diseases. A noteworthy proportion (61.90%) of poultry farmers reported that they utilized herbs as a disease and parasite control policy (Table 5). Aloe species was exemplified as the commonly used herb in treating diarrhoea (62.96%), respiratory infections (61.97%) and in worm control (64.55%). Farmers selected herb option based on what other farmers (74.19%) used as compared to availability (0.00%), herb effectiveness (24.73%) or other sources (1.08%) such as internet (Table 5).

3.6 Indigenous Chicken Disease Reporting and Communication

Results on IC farmer's disease reporting, communication channels and sources of IC related information are presented in Table 6. Majority (76.87%) of farmer did not report cases of infections among their flock while those who reported (23.13%) mainly communicated to government (36.73%) and private (34.69%) veterinarians (Table 6). Majority (72.11%) did not have access to poultry health services. Those who had access to poultry health services (27.89%) mainly accessed through government and private veterinary personnel. Farmers mainly accessed information on poultry disease control from radio (26.45%), other farmers (25.62%) government and private vets (15.70%), (16.53%) in contrast to mobile phones (1.65%) and other (1.65%) sources such as flyers (Table 5). Compared to poultry farmers with access to poultry diseases control information (44.90%), majority had no access (55.10%) to information on disease control (Table 6).

Table 3. Characteristics of Indigenous Chicken (IC) production system

Variables	**Description**	**Busia**	**County**	**Machakos**	**County**	**Overall mean** (%)
		Teso-South (n=42)	**Nambale (n=30)**	**Yatta (n=31)**	**Mwala (n=44)**	
Mixed poultry species	Yes	55.26	36.84	1.32	6.58	51.70
	No	0.00	2.82	42.25	54.93	48.30
Poultry breeds	Exotic only	0.00	0.00	0.00	0.00	0.00
	Cross-breed	0.00	0.00	0.00	0.00	0.00
	Indigenous	0.00	0.00	55.36	44.64	38.10
	Both exotic and indigenous	46.15	32.97	0.00	20.88	61.90
Flock size	Number of chickens	57.50±48.24	35.7± 34.63	31.00 ± 15.10	46.45 ± 36.52	43.14 ± 40.02
Flock structure	Chicks*(3months)*	10.48 ± 6.82	12.10 ± 6.20	9.87 ± 5.74	16.45 ± 8.31	12.47 ± 7.50
	Growers*(3-6months)*	4.45 ± 0.01	4.83 ± 1.33	19.87 ± 6.41	14.09 ± 7.06	10.67 ± 4.16
	Pullets and Cockerels*(6-12)*	3.81 ± 1.59	6.57 ± 4.68	7.80 ± 6.92	11.32 ± 5.11	7.46 ±4.14
	cocks	5.26 ± 3.74	3.48 ± 1.22	2.13 ± 1.12	3.88 ±2.04	3.83 ± 1.28
	Hens	7.33 ± 3.21	8.67 ± 4.72	5.13 ± 4.88	12.50 ± 4.88	8.67 ± 4.77
Change in flock size	Yes	3.75	2.50	38.75	55.00	54.42
	No	58.21	41.79	0.00	0.00	45.58
IC dynamics	Sold	9.38 ± 4.70	11.80 ± 6.90	23.06 ± 7.94	28.75 ± 5.77	82.56 ± 7.38
	Consumed	23.55 ±7.39	7.93 ± 4.36	10.23 ± 8.45	10.02 ± 8.08	13.50 ± 9.51
	Donation e.g., gifts	3.02 ± 2.41	2.20 ± 1.56	3.03 ± 2.64	4.16 ±2.19	3.20 ± 2.20
Egg production	Incubated	65.40 ±9.27	75.67 ± 9.67	48.70 ± 7.60	110.8±10.08	77.56 ± 9.38
	Sold	0.95 ± 0.84	5.00 ± 3.71	16.51 ± 7.21	40.36 ± 12.24	16.86 ± 6.00
	Consumption	21.05 ± 4.76	14.67 ± 7.11	20.58 ± 12.97	45.60 ± 9.60	27.00 ± 8.61
	Donation e.g., gifts	0.29 ± 0.17	0.00±0.00	2.68±0.77	6.25±2.26	2.31±1.05
Chick performance	Hatched	53.86 ± 25.24	40.10 ± 29.08	38.48 ± 21.66	79.52 ± 52.30	52.99 ± 38.88
	Survived to 3 months	37.90±21.33	26.83±22.02	26.03±22.26	62.15± 35.68	38.23±25.32
	Survived to 6 months	23.31 ±14.30	14.6±13.15	20.90± 15.72	40.39 ±29.30	24.80±18.11
Feed types - chicks	Nothing	48.08	50.00	0.00	1.92	35.37
	Food Scraps	20.00	0.00	0.00	80.00	3.40
	Concentrates	17.07	4.88	28.05	50.00	55.78
	Others	0.00	0.00	100.00	0.00	5.44
Variables	**Description**	**Busia**	**County**	**Machakos**	**County**	**Overall mean** (%)

		Teso-South (n=42)	Nambale (n=30)	Yatta (n=31)	Mwala (n=44)	
Growers	Nothing	48.00	48.00	4.00	0.00	34.01
	Food Scraps	4.76	0.00	9.52	85.71	14.29
	Concentrates	37.04	5.56	16.67	40.74	36.73
	Others	0.00	0.00	81.82	18.18	14.97
Adult birds	Nothing	51.56	45.31	3.13	0.00	37.43
	Food Scraps	0.00	0.00	2.44	97.56	23.98
	Concentrates	18.92	2.70	16.22	62.16	21.64
	Others	0.00	0.00	68.97	31.03	16.96

Table 4. Indigenous chicken disease and parasite constraints

Variables	Description	Busia	County	Machakos	County	Overall mean (%)
		Teso-South (n=42)	Nambale (n=30)	Yatta (n=31)	Mwala (n=44)	
Diseases	NewCastle Disease	21.79	6.41	24.36	47.44	18.48
	Influenza Coryza	53.13	45.31	0.00	1.56	15.17
	Gumboro Disease	22.97	13.51	9.46	54.05	17.54
	Coccidiosis	18.84	26.09	15.94	39.13	16.35
	Fowl Typhoid	60.00	33.33	3.33	3.33	7.11
	Fowl Cholera	45.45	9.09	36.36	9.09	2.61
	Pullorum	43.75	40.63	15.63	0.00	7.58
	Fowl Pox	23.44	6.25	9.38	60.94	15.17
Disease symptoms	Greenish diarrhoea	32.14	26.79	13.39	27.68	24.89
	Whitish diarrhoea	13.64	1.52	25.76	59.09	14.67
	Pox lesions	46.27	8.96	11.94	32.84	14.89
	Bloody diarrhoea	17.24	3.45	8.62	70.69	12.89
	Difficulty breathing	16.67	0.00	72.22	11.11	4.00
	Coughing	33.65	25.96	14.42	25.96	23.11
	Sudden death	16.00	0.00	84.00	0.00	5.56
Newcastle Outbreak	Yes	33.75	3.75	21.25	41.25	45.58
	No	22.39	40.30	20.90	16.42	54.42
Newcastle mortality	IC mortality	5.35± 2.23	1.53± 0.15	3.74± 1.27	7.45± 5.99	4.86± 2.66
Gumboro Outbreak	Yes	34.18	2.53	17.72	45.57	53.74
	No	22.06	41.18	25.00	11.36	46.26
	IC infections	6.35±5.62	0.53± 0.10	2.87± 1.20	6.04±4.95	4.34± 2.10
	IC mortality	5.54± 3.00	0.40 ±0.19	2.74± 1.82	3.77± 1.42	3.37± 1.27
Coccidiosis outbreak	Yes	39.33	7.87	11.24	41.57	60.54
	No	12.07	39.66	36.21	12.07	39.46
	IC infections	4.19±2.51	1.06± 0.24	1.39 ± 0.44	3.95±2.03	2.89±2.68
	IC mortality	3.04±1.79	0.53± 0.38	0.26 ±0.05	1.81± 0.12	1.57±0.93
Parasites	Lice	12.70	4.76	22.22	60.32	22.26
	Fleas	8.86	27.85	36.71	26.58	27.92
	Mites	36.59	28.05	21.95	13.41	28.98
	Worms	0.00	1.72	31.03	67.24	20.49
	Others	0.00	0.00	0.00	100.00	0.35

Table 5. Indigenous chicken disease control and management

Variables	Description	Busia	County	Machakos	County	Overall mean (%)
		Teso-South (n=42)	Nambale (n=30)	Yatta (n=31)	Mwala (n=44)	
Parasite control	None	40.00	47.27	12.73	0.00	34.81
	Dewormers	23.94	4.23	21.13	50.70	44.94
	Herbs	3.13	0.00	28.13	68.75	20.25
	Others	0.00	0.00	0.00	0.00	0.00
Use of vaccine	Yes	30.84	23.36	15.89	29.91	72.79
	No	22.50	12.50	35.00	30.00	27.21
	Newcastle	30.10	24.27	15.53	30.10	51.76
	Gumboro	34.78	21.74	7.25	36.23	34.67
	Fowl pox	51.85	22.22	0.00	25.93	13.57
	Fowl typhoid	0.00	0.00	0.00	0.00	0.00
Use of herbs	Yes	19.78	7.69	26.37	46.15	61.90
	No	42.86	41.07	12.50	3.57	38.10
Diarrhoea treatment	Aloe Species	22.35	7.06	23.53	47.06	62.96
	Neem	0.00	0.00	0.00	0.00	0.00
	Pawpaw	100.00	0.00	0.00	0.00	8.15
	Pepper	52.38	0.00	23.81	23.81	15.56
	Sisal	0.00	0.00	0.00	0.00	0.00
	Acacia	0.00	0.00	0.00	100.00	1.48
	Others	0.00	0.00	62.50	37.50	11.85
Respiratory treatment	Aloe Species	21.59	6.82	23.86	47.73	61.97
	Neem	0.00	0.00	0.00	0.00	0.00
	Pepper	66.67	0.00	12.50	20.83	16.90
	Pawpaw	100.00	0.00	0.00	0.00	10.56
	Acacia	0.00	0.00	0.00	100.00	1.41
	Others	0.00	0.00	46.15	53.85	9.15
Worm control	Aloe Species	25.35	8.45	21.13	45.07	64.55
	Neem	0.00	0.00	100.00	0.00	0.91
	Pepper	45.16	0.00	6.45	48.39	28.18
	Acacia	0.00	0.00	0.00	100.00	0.91
	Others	0.00	0.00	66.67	33.33	5.45

Variables	**Description**	**Busia**	**County**	**Machakos**	**County**	**Overall mean** (%)
		Teso-South (n=42)	**Nambale (n=30)**	**Yatta (n=31)**	**Mwala (n=44)**	
Mode of herb selection	Other farmers	1.45	0.00	34.78	63.77	74.19
	Availability	0.00	0.00	0.00	0.00	0.00
	Effectiveness	78.26	21.74	0.00	0.00	24.73
	Others	0.00	0.00	100.00	0.00	1.08

Table 6. Indigenous chicken disease reporting and communication

Variables	Description	Busia	County	Machakos	County	Overall mean (%)
		Teso-South (n=42)	Nambale (n=30)	Yatta (n=31)	Mwala (n=44)	
Report diseases	Yes	30.09	25.66	24.78	19.47	23.13
	No	23.53	2.94	8.82	64.71	76.87
	Government vet	0.00	38.89	5.61	55.56	36.73
	Private vet	11.76	0.00	17.65	0.59	34.69
	NGO	0.00	0.00	0.00	100.00	12.24
	CAHW	0.00	0.00	100.00	0.00	2.04
	Local administrator	0.00	0.00	0.00	100.00	14.29
Poultry health services	Yes	19.51	0.00	29.27	51.22	27.89
	No	32.08	28.30	17.92	21.70	72.11
	Government vet	28.57	0.00	28.57	42.86	44.68
	Private vet	13.33	0.00	13.33	73.33	31.91
	NGO	0.00	0.00	18.18	81.82	23.40
	CAHW	0.00	0.00	0.00	0.00	0.00
Disease control info.	Yes	12.12	0.00	22.73	65.15	44.90
	No	41.98	37.04	19.75	1.23	55.10
	Government vet	26.32	0.00	31.58	42.11	15.70
	Private vet	5.00	0.00	10.00	85.00	16.53
	Other farmers	0.00	0.00	9.68	90.32	25.62
	Radio	0.00	0.00	12.50	87.50	26.45
	Television	0.00	0.00	0.00	100.00	9.09
	Internet	0.00	0.00	100.00	0.00	3.31
	Mobile phone apps	0.00	0.00	100.00	0.00	1.65
	Others	0.00	0.00	100.00	0.00	1.65

4. DISCUSSION

In this study, preliminary baseline data was collected using a structured questionnaire prior to validation of three climate-smart technologies from purposely recruited farmers within Machakos and Busia Counties of Kenya. The results revealed that the mean age of farmers was 50 years, implying that they were still in their active productive age to manage available IC resources. These findings, concur with those reported elsewhere in developing countries [14, 17,18,19). This is probably because of relative immobility and a decline in the ability to perform physical tasks among elderly farmers. Kimhi and Bollman [20] showed that farmers over a particular age will probably "exit" from agricultural farming practices as they age on. Similarly, Breustedt [21]pointed out that after establishing themselves in agribusiness, young farmers' particularly youthful agriculturists swiftly increase the dimensions of farm operations and cultivating ventures in the first decade of operation.

Data from this study indicate majority of the poultry farmers had formal education (97%) in contrast to those without formal education. Formal education opens the mind of the poultry farmer to knowledge through hands-on training, and better methods of chicken productionthus keeping the farmers abreast with changing innovations and ideas. This corroborates findings by Eric andElfreda [22], who showed that education enhances agricultural productivity primarily by improving farmers' decision-making ability and secondarily by alleviating their technical efficiency.However, this is contrary to findings by training Mandal et. al. [23] in India and Swai et. al. [24] in Tanzania who revealed that over 90% of indigenous chicken owners acquired low (primary level and below) to no formal education. They attributed this to the low income witnessed in most households in the study areas, most farmers could not afford the cost of education (especially higher level) causing majority of youth to drop out of school.

Results further divulge that agriculture was the predominant (80%) economic activity among poultry farmers. Perhaps this is because farming is considered the fabric of rural society and in many countries of the world; it is the main economic activity. Any sudden and profound changes which impact the farm sector could have severe consequences in terms of social and political stability in economically developing countries. According to Dethier and Effenberger [25], the agricultural sector continues to play a crucial role in development, especially in low-income countries where the sector is large both in terms of aggregate income and total labor force. Similarly, Aker [26]argued that agriculture contributes to growth in developing countries by generating income, employment and providing food at reasonable prices in urban areas and can therefore be an effective tool to reduce poverty.

The results of this survey reveal that 59% of the respondents practiced semi-intensive poultry farming. This could probably be due to its economical use of land in comparison to the free-range system and to an extent, scientific management operations can be applied in this system with huge benefits to the farmer. According to Wantasen*et al.* [27],advantages of a semi-intensive poultry production system include low investments and higher returns, significant savings in feed costs, better meat quality, the meat is lean and fat-free compared to broilers grown in confined cages, and better returns to the entrepreneur.

Over 96% of poultry farmers in this study were members of local agricultural groups. This could bedue to the fact that membership to a social group widens farmers' interactive tendencies, exchange of ideas relating to their farming activities and market opportunities. This observation concurs with[28, 29]who reported membership to cooperatives enhance farmers' access to input and output markets which is necessary for the non-disruptive flow of poultry resources for meeting sustainability requirements of production. This is in line with findings by Justus et al. [30]who reported that 75.8 % of the farmers were members of various Self Help Groups (SHGs). This was mainly because membership to groups helps farmers to access group credit, share agricultural labor, joint input purchase, joint vaccination against common diseases, extension services, lobby for favourable agricultural policies and promote unity among farmers.

This study revealed that respondents mainly preferred a blend of indigenous and exotic breeds of chicken (68%) perhaps due to the high tolerance among indigenous chickens to diseases, climatic conditions, scavenging ability, improved meat and egg productivity among exotic birds. Findings elsewhere by Gebremariam and Gebremariam [31] revealed that exotic chickens were treasured for their high egg production and crossbred chickens were valued for their intermediate characteristics of being adaptive and possessing economically important traits. Studies elsewhere by Teklewold *et al.* [32] showed that trait categories like high egg and meat production ability were among the principal factors determining farmers' choice and adoption of improved chicken breeds. Terfaet al. [33] reported that farmers preferred indigenous chickens mainly for their disease resistance abilities, mothering capability, good meat and egg taste as indicated by the positive and significant coefficient.

The overall average chicken flock size of (43.14) found in this study was higher than those reported in other developing countries by [34,35]. However, chicks constituting the largest proportion of the flock have been reported [36,37]. This could be due to the variation in the availability of feed, the presence of different diseases of various aetiologies, predators and the socio-economic status of the owners. Indigenous chickens were mainly kept as a source of income and chicks were primarily supplemented with concentrates. The readily available markets and the ever-increasing demand for IC products especially live chicken both in rural and urban households [38,39] could explain their high ranking as a source of income. According to young chicks (1-4 weeks old) are given priority towards supplementary feed. Similarly, research findings by Fisseha [40] indicated that majority of chicken owners in Bure district, western Ethiopia, gave prioritized giving supplements to young chicks to encourage growth and maintain flock health.

The most prevalent diseases (Newcastle (18.48%), Gumboro (17.54%) coccidiosis (16.35%), parasites (Mites (28.98%), fleas (27.92%) and infection symptoms (greenish diarrhoea (24.89%), coughing (23.11%), pox lesions (14.89%) identified in this study are in line with findings by [31,38,41]. The seasonal outbreak of diseases, especially Newcastle disease and greenish diarrhoea observed in this study, has also been reported to cause high mortalities elsewhere [27,42,43]. Notification of the season of outbreaks in this study could be used to schedule vaccination programs against these diseases, i.e. chickens can be vaccinated during dry seasons so that they develop immunity before the outbreaks in the wet seasons.

Results from this study revealed that poultry farmers utilized vaccines, dewormers and herbs such as Aloe species and other local herbs to guard against prevalent diseases among chicken this is consistent with findings by [44,45] who argued that vaccination programmes and ethno-veterinary medicine such *Aloe secundiflora* and *Aloe ferox* can be used to treat and control diseases in indigenous chicken. This study also showed that farmers mainly chose the type of herbs based on recommendation and influence from other farmers. This concur with findings elsewhere by Kilpatrick and Johns [46] who reported that farmers preferred to learn principally by seeking information and advice on a one-to-one basis from more than one person, most frequently experts, but often other farmers.

The high proportion of farmers who had neither reported cases of infection (76.9%) nor had access to poultry extension services (72.1%) is in tandem with Oyebode and Adebisi [19]who reported low access to information from extension agents which may be largely attributed to the disproportionate extension agents to farm family ratio experienced in public extension which has led to the dwindling services provided by extension agents. The high dependence on radio for information on poultry production is believed to be so, because radios are portable, cheap to maintain, have a wide coverage with an array of stations its users can access for information. This is in consonance with findings by[47, 48]who identified radio and television as major sources of information on health, agriculture and related activities. The observed low patronage of the internet and mobile phones (1.65%) for information can be attributed to lack of expertise and cost of accessing information through this platform. This observation is supported by Easdown and Starasts [49], who reported that internet is not available and its value is not appreciated due to its high cost, lack of skill and limited time to explore it for relevant information.

5. CONCLUSION

The objective of this study was to collect preliminary baseline data using a structured questionnaire prior to validation of three climate smart technologies within project sites. The conclusions areas follows:

a) The socio-economic characteristics of respondents portray a set of farmers who are in the actively productive age of 50 years, with formal education and solely derive their household livelihood in terms of food provision and income generation from IC poultry farming.

b) The semi-intensive IC production system reported in this study is characterized by small flock sizes of 43 birds with good meat quality, low investments, and modest returns to the entrepreneurs. Preference for IC in the study was probably due to their tolerance to diseases, adaptability to harsh climatic conditions, scavenging ability and improved meat and egg productivity.

c) Newcastle, Gumboro, coccidiosis, mites and fleas were major disease and parasite constraints in the study, where only a few farmer respondents reported cases of infection and accessed the government extension services. Notably, reported diseases were all preventable through strict routine vaccination programs and awareness through education on ectoparasite control. Interestingly, only a few IC farmers utilized vaccines, dewormers and Aloe herbs for the control common diseases affecting chicken. This calls for targeted poultry management intervention strategies from all the relevant stakeholders for improved IC poultry farming.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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